OFFICIAL PROCEEDINGS

RAILWAY CLUB OF PITTSBURGH

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WORKMEN'S COMPENSATION, A STUDY IN EVOLUTION

BY C. W. GARRETT, SECRETARY, COMMITTEE ON WORKMEN'S COMPENSATION, PENNSYLVANIA LINES WEST OF PITTSBURGH.

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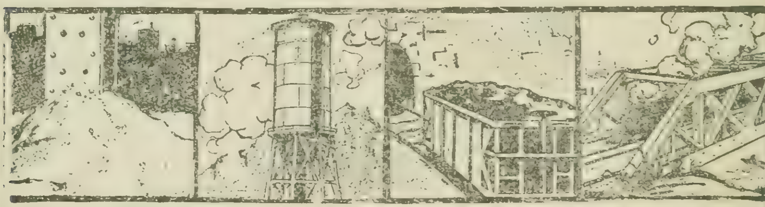

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OFFICIAL PROCEEDINGS

OF

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, NOVEMBER 28th, 1913.

The meeting was called to order at the Monongahela House, Pittsburgh, Pa., on Friday, November 28, 1913, at 8 o'clock, P. M., by President A. G. Mitchell.

The following persons registered:

MEMBERS

Amsbary, D. H.
Anderson, J. B.
Ashley, F. B.
Babcock, F. H.
Baker, E. C.
Battinhouse, J.
Balsley, W. T.
Berg, K.
Brantlinger, J. H.
Brewer, W. A.
Buechner, W. A.
Burry, V. J.
Burke, Wm.
Cassiday, C. R.
Chapman, B. D.
Code, J. G.
Cole, Jewett
Copeland, Thos. F.
Cook, Jos. A.
Courtney, D. C.
Dambach, C. O.
Deneke, W. F.
Detwiler, U. G.
Donovan, P. H.
Duggan, E. J.
Falkenstein, W. H.
Ferren, Robt. O.
Forsythe, Geo. H.
Frazier, E. L. Jr.
Gillespie, W. J.
Greiff, J. C.
Grewe, H. F.
Grove, E. M.
Harriman, H. A.
Hays, Milton D.
Haynes, J. E.
Herrold, A. E.
Herbick, N.
Higgins, H. L.
Howe, Harry
Hudson, W. L.
Hurley, Theo.
Knight, E. A.
Lanahan, Frank J.
Laughlin, E. J.
Lindstrom, Chas. A.
Low, J. R.
Lowry, R. W.
Lynn, Sam'l
Mason, Stephen C.
Maxfield, H. H.
Mensch, E. M.
Millar, C. W.
Mitchell, A. F.
Mitchell, A. G.
McFarland, H. L.
McFeatters, F. R.
McNaight, A. H.
McNulty, F. M.
Newman, L. L.
Noble, D. C.
Pearson, A.
Perry, W. E.
Porter, H. V.
Postlethwaite, C. E.
Pratt, I. D.
Pulliam, O. S.
Rabold, W. E.
Raser, Geo. B.
Ream, A. H.
Redding, D. J.
Richardson, L.
Richardson, W. P.
Robbins, F. S.

Runser, K. W.	Toomey, J. J.
Ryan, W. F.	Turner, Walter V.
Schomberg, W. T.	Ulmer, E. F.
Shourek, T. L.	Walter, W. A.
Smith, J. B.	Warne, J. C.
Smith, J. H.	Wardale, N. H.
Smoot, W. D.	Wittig, Wm.
Summers, J. R.	Wright, R. V.

Wyke, J. W.

VISITORS.

Amhill, P.	Hinkley, H. W.
Barton, J. H.	Huston, F. T.
Boggs, A. C.	Jones, W. H.
Caldwell, W. J.	Keiper, R. H.
Dodds, A. W.	Maier, J. L.
Englert, A. F.	McGinnis, D. S.
Evans, R. W.	Pickett, H. D.
Fulton, A. M.	Super, S. L.
Garrett, C. W.	Sarver, G. E.
Henry, L. C.	Warne, H. A.
Hunter, J. A.	Watkins, G. H.

The call of the roll was dispensed with, because of having a record of the attendance on the registry cards.

The reading of the minutes of the last meeting was dispensed with, they having been already printed and distributed.

The Secretary announced the following applications for membership:

Boggs, A. C., Civil Engineer, Penna. Co. 294 East Second Street, Beaver Pa. Recommended by E. A. Knight.

Burt, Morris F. Jr., Draftsman, Borough Engineer, South Brownsville, Pa. Recommended by D. H. Kinter.

Courtney, H., Draftsman, P. & L. E. R. R., 102 Freeland Street, Pittsburgh, Pa. Recommended by V. J. Burry.

Emery, E., Railway Supplies, 1305 Farmers Bank Building, Pittsburgh, Pa. Recommended by R. H. Blackall.

Englert, A. F., Chief Piece-Work Clerk, American Locomotive Company, 2 Drum Street, N. S., Pittsburgh, Pa. Recommended by William Wittig.

Fleharty, J. H., Assistant Manager, Jos. T. Ryerson & Son,

Western Reserve Building, Cleveland, O. Recommended by G. M. Basford.

Hershey, Jas. E., Insurance Solicitor, 226 Frick Building, Pittsburgh, Pa. Recommended by J. Rush Snyder.

Hink, Geo. L., Piece-Work Inspector, P. R. R. Redman Mills, Pa. Recommended by A. J. Voigt.

Hinkley, H. W., Civil Engineer, Penna. Co., 1882 Clayton Ave., N. S., Pittsburgh, Pa. Recommended by E. A. Knight.

Hughes, H. H., Pittsburgh Sales Manager, Hooven, Owens, Rentschler Co., 617 Oliver Building, Pittsburgh, Pa. Recommended by S. D. Shook.

Jameson, A. A., Clerk, Penna. R. R., 410 Colonial Apartment, Wilkinsburg, Pa. Recommended by W. E. Rabold.

Kennedy, O. E., Auditor, Little Kanawha Syndicate Lines, 514 Oliver Building, Pittsburgh, Pa. Recommended by Frank Ryman.

Mahey, Chas. G., Bookkeeper, Expanded Metal Fireproofing Co., 541 Wood Street, Pittsburgh, Pa. Recommended by F. M. McNulty.

McGough, J. E., Locomotive Engineer, W. P. T. Ry., East Carnegie, Pa. Recommended by C. O. Dambach.

Oliver, R. G., Pittsburgh Representative, Merser & Co., 5133 Jenkins Arcade, Pittsburgh, Pa. Recommended by B. Kopfershmidt.

Pie, J. J., Gang Leader, Penna. R. R., 320 Orchard Street, Knoxville, Pa. Recommended by A. J. Voigt.

Searle, J. M., Chief, Division of Smoke Inspection, City of Pittsburgh, Nixon Building, Pittsburgh, Pa. Recommended by J. B. Anderson.

Spielman, J., Engineer, M of W. B. & O. R. R., Pittsburgh, Pa. Recommended by C. O. Dambach.

Trautman, H. H., Clerk, Penna. R. R., Box 317, Wilmerding, Pa. Recommended by V. V. Wood.

Tutwiler, L. H., Traveling Storekeeper, B. & O. R. R., Pittsburgh, Pa. Recommended by J. H. Cooper.

Watkins, Geo. H., Assistant Master Mechanic, Penna. R. R.,

28th and Liberty Avenue, Pittsburgh, Pa. Recommended by H. H. Maxfield.

Woods, Floyd F., Special Representative, Epping-Carpenter Pump Co., 1376 Montezuma Street, Pittsburgh, Pa. Recommended by S. D. Shook.

Yon, Harry C., Scale Agent, Penna. R. R., 532 Fallowfield Ave., Charleroi, Pa. Recommended by B. F. Livingston.

Zortman, C. E., Division Engineer, Penna. R. R., 1003 Penn Ave., Pittsburgh, Pa. Recommended by A. G. Mitchell.

The Secretary announced the death of Mr. J. McAndrews, General Yard Master, Pennsylvania Lines West, who became a member of the Club, April 22, 1904.

SECRETARY: We have a communication from A. J. Merrill, Secretary, Southern & Southwestern Railway Club, Atlanta, Ga., to Mr. F. M. McNulty, First Vice President calling attention to a pamphlet on "Handling modern trains from the air brake standpoint" by Robert Burgess of The Westinghouse Air Brake Co., read before the Southern & Southwestern Railway Club in the month of July 1913. This pamphlet can be obtained from Mr. Merrill at a cost of seven cents per copy.

PRESIDENT: We will now proceed with the paper of the evening, on "Workmen's Compensation, a Study in Evolution," by Mr. C. W. Garrett, Secretary, Committee on Workmen's Compensation, Pennsylvania Lines West of Pittsburgh.

WORKMEN'S COMPENSATION, A STUDY IN EVOLUTION.

By C. W. Garrett, Secretary, Committee on Workmen's Compensation, Pennsylvania Lines West of Pittsburgh.

"Workmen's Compensation" is but one branch of "Workingmen's Insurance," which, in turn, is but one of many kindred divisions in the general "Labor Legislation" movement.

Workmen's Compensation is generally understood to mean any or all of the several plans under which a workman injured in the course of his employment shall automatically, while disabled by such injury, be paid a certain part of his usual wage,

regardless of any questions as to liability or fault. The other fields of workingmen's insurance are classed broadly as "Sickness Insurance" (including injuries while not on duty and occupational disease), "Old Age Insurance" (or Pensions), and "Unemployment Insurance" (or the payment of partial wages while involuntarily out of employment). Each of these branches has been developed independently, but there is now evolving a tendency to consider them together and correlate them logically.

A great deal of attention has been given all these problems in European countries for many years, but it is only recently that much interest has been taken in them in the United States. Here, matters have not progressed far enough to enlist any interest in a comprehensive plan for covering all the branches of workingmen's insurance, but there has been a popular demand for some sort of workmen's compensation legislation that would be compatible with our democratic ideas as to "equal rights for all,"—employers, workmen, and the public.

This is the department of workingmen's insurance in which you as railroad men are just now most interested, for there is pending national legislation on the subject applicable to all common carriers, the result of a study by a special Government Commission which reported in December 1911; and while no immediate action on the report is to be expected, the general discussion which it has invoked will doubtless lead to some future legislation.

As Pittsburghers, you are also particularly interested in the problem, for in "Work Accidents and the Law," by Crystal Eastman, (a report on one section of the famous "Pittsburgh Survey,") your community has been held up to the world as a "horrible example" of the failure of employers to make any provision for their injured men, and of the misery and went which follow almost inevitably in the wake of all serious industrial accidents not compensated for. It is true that the report was made just before the adoption of a more liberal policy in this matter on the part of some of the employers concerned, and the book even mentioned this new policy; but the newer conditions have not been so widely advertised as the old, and the world is still having its attention called daily to the old report.

Within the last four years, laws have been passed in six-

teen individual states providing compensation for workmen injured in their industries. These states are:*

Arizona, 1912.
California, 1911.
Illinois, 1911 and 1913.
Kansas, 1911.
Maryland, 1910 and 1912.
Massachusetts, 1911.
Michigan, 1912.
Nevada, 1911.
New Hampshire, 1911.
New Jersey, 1911.
New York, 1910.
Ohio, 1911 and 1913.
Rhode Island, 1912.
Washington, 1911.
West Virginia, 1913.
Wisconsin, 1911 and 1913.

In a few of them the compensation laws have attempted to be broad enough to include railway employees in their workings, but in the most of them, all men employed in interstate commerce have been omitted or excluded from the provisions of the act, and as most of the employees of the railways have been legally held to be engaged in interstate commerce, any general application of the compensation plan to railway employees must await congressional action.

In several other states, special commissions have been at work; some of them have reported but the recommended legislation has failed of passage. Among these is Pennsylvania.

Since you have doubtless seen the report of the Commission of your own State, and know in a general way what is proposed in the way of national legislation, I have thought that you would be more interested in hearing something of the general history of the movement and its gradual development, or evolution, than in the details of the various bills passed and proposed.

A century ago there was no workmen's compensation prob-

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* Subsequent to the preparation of this paper, information was received of the passage of Compensation bills in six additional States during 1913; Connecticut, Iowa, Nebraska, Minnesota, Oregon and Texas; and of the modification of previous laws in four States: California, Kansas, Nevada and New Jersey.

lem. Industries were simple, employing at the most but a few men, and these usually at hand work for which they selected and in most instances owned their own simple tools. When a man was injured, the injury was rarely serious, and the fault was entirely his own or that of his friend who worked with him. If he was unable to care for himself and family while not able to work, they became public charges. No one thought of asking the employer to assume any responsibility except such as any other citizen might.

But as industries developed in size and complexity with the introduction of steam power and machinery, the relations of employer and employed underwent a gradual modification. Within a few decades, plants had become so large that an employer could no longer be acquainted with each of his men and their individual capability, but it was apparent that he must be held to some sort of responsibility for the personal safety of his employees. From the recognition of more or less legal responsibility for damages to a man injured through what could clearly be proven to be the fault of the employer, arose the principle of "employers' liability."

At first this liability was very slight and but seldom proven, and was hardly worthy of the name. It was, in 1837, almost completely overthrown by the decision in the much-written-about "Priestly case" (in England), which became the precedent in all cases where the fault of a "fellow servant" could be shown by the employer to have been responsible in whole or in part for the injury. This was a case in which a butcher's helper was injured through the carelessness of a wagon driver in the same employ. A claim for damages was entered against the butcher, but it was held that he should no more be liable for the act of the driver than should the helper who was working with him and was injured, and that to hold an employer liable for all the acts of his servant might have such far-reaching consequences as to be most inconvenient and even absurd.

This was doubtless fair enough in the case at issue, but as industries grew so large and complex that in nearly all cases of injury it could be shown that some co-worker was at least in part at fault, the basing of all subsequent decisions on this precedent resulted in depriving most injured men of assistance at law.

Another bar to recovery of damages in many cases was the doctrine of "assumption of risk," a survival also from the days of simple employment. By this doctrine, each man upon entering the employ of another was supposed to assume all the risks of that employment, on the theory doubtless that the wage was based in part on that risk. The practical result of this assumption was that in injuries where no one was at fault, but the accident was due to inherent risks in the employment, there was no possibility of recovery of damages.

Still another bar to recovery was found in the doctrine of "contributory negligence," under which if it could be shown that the injured man was in any way careless or at fault, although the main fault may have been that of the employer, he had "contributed" to the cause of the injury and the employer could not be held liable for damages.

The net result was that, say forty years ago, the burden of industrial accidents fell mainly on the injured men and their families, pretty much the world over. The weight of this burden was of course felt most in those countries where wages were low and competition for places keen, and it was in those countries that the problem of distributing this burden first became a subject of general and vital interest. For when the wages of workmen amount only to the actual cost of necessary subsistence, there is no reserve to tide over any period without wages, and the need of financial assistance in such emergencies is urgent.

The first effort to meet this need was made by the workmen themselves. They banded together in mutual aid and "Friendly Societies," in which the main feature was an insurance against the loss of wages from either accident or sickness. But in the very countries where such assistance was most needed, workmen were least able to avail themselves of it, for the plan involved setting aside regularly a portion of the wages to provide the insurance, which they could ill afford to spare. These societies were, however, successful in so large a measure that they have continued through all the changing conditions today. We have an example of the application of their principles, modernized, in the Relief Departments of the Pennsylvania, Baltimore and Ohio, and several other railroads.

In continental Europe, the need of some state or national

action for the relief of those injured in the course of their occupation was greatest, and Germany was the first country to take such a step. The movement was inaugurated by the passage of laws compelling employers of certain classes to assist the voluntary associations for accident and sick insurance. This was followed with a law making employers liable for accidents where any fault whatever could be shown to lie at their door, but applied only to mine operators. Due probably to the active interest shown by Bismarck, as well as to the earnest pleading of economists and philanthropists, Emerpor William I, in 1881, launched the movement for the first real Workmen's Compensation Act of the world, which was passed in 1884, much to the financial relief of the peasant workmen of the empire. It was a comprehensive system of compulsory insurance, in the cost of which the employers and workmen shared, and in the operation of which each had a voice, subject to governmental regulation and control.

After watching the result in Germany for a few years, other European countries passed various laws toward the same end. Austria, Hungary, Belgium, Italy, France, Denmark, Spain, Norway, Sweden, the Netherlands, and, finally, Great Britain, passed Workmen's Compensation laws, but in all these countries the employers were required to pay the entire cost of the insurance against accidents due to the employment. The Australian States, and a number of British dependencies also adopted the European plan. Only last year, the republic of Switzerland, by referendum vote, approved a compulsory compensation plan applying to practically all industries, the premiums to cover accidents due to the employment to be paid entirely by the employers.

Some of these European plans provide that the employers should pay the accident benefits direct to the injured men; some that a state insurance fund or an association of employers should receive the premiums and disburse the benefits; others made it optional which plan should be adopted by individual employers.

It was not until about 1898 that writers in the United States began to take an interest in the subject of Workmen's Compensation, and to call attention to the fact that ours was the only industrial country which had taken no action for the relief of injured workmen. The few pioneers did not succeed in awakening any very general interest in the matter until about ten years

ago, when writers and students of industrial problems began to flood the country with articles on the subject, and organizations of employers, workmen and philanthropists turned to a serious study of the problem of caring for injured workmen and their families.

In the meantime, during the last twenty years, there had been many changes made in the employers' liability laws of the States and of the nation. These have been gradually broadened until the relation of the employer and employee has been practically reversed. Where formerly the employer could be held accountable only when it could be proven beyond a doubt that he was at fault, now he is held responsible for practically all accidents unless he can show that the injured man was himself solely to blame; or he is held proportionately responsible with the injured man on the basis of their "comparative negligence."

But, during the period of transition, there has been interminable litigation over most of the important cases, and often several years have elapsed between the date of the injury and the recovery of a judgment. And when the case was finally settled, the man has found himself out of employment. The cost of this litigation has absorbed a goodly portion of the money paid by the employers, so that the injured man (or his family) has usually suffered great financial distress, in addition to the pain of the injury or the loss of the breadwinner.

The result has been that in the last decade there has developed a pretty general demand in this country that the employers' liability laws should be superseded by a Workmen's Compensation system. Instead of settling for personal injuries on the old basis of fault, it is the tendency on every hand to insist that all personal injuries be compensated for, unless the injured man was grossly negligent of his own safety, and that this compensation be paid directly to the beneficiaries without being wasted in lawyers fees and court costs.

In response to this demand, the first real Workmen's Compensation Act to get upon the statute books in the United States was one of the federal government, of May 30, 1908, providing for the continuation of wages for one year to men injured in any of the particularly hazardous branches of the government service, where the work and risk were similar to conditions in plants of private employers, and for the continuation of the wage

payments for one year to the dependents of those killed in that service.

The following year, March 4, 1909, Montana passed an act establishing a state co-operative insurance fund covering men employed in the mines of that State, the premiums being paid jointly by the employers and the miners, but two years later this law was declared unconstitutional.

On June 18th of the same year, Massachusetts passed an act authorizing an employer who so desired to try a compensation plan, but nothing came of the experiment and the law was superseded by an act of 1911 providing for a state insurance fund in which employers might optionally insure their workmen against accident.

On April 7, 1910, the legislature of Maryland authorized the Counties of Allegheny and Garrett to establish co-operative insurance funds for the coal miners in those counties, the premiums being paid equally by employers and miners.

The legislature of New York then passed two bills; the first comprehensive Workmen's Compensation Acts in this country. The first one, approved May 24, 1910, provided an optional plan of compensation covering all industries but the railroads. It still stands but it is not extensively used. The second one, approved June 25, 1910, provided for compulsory compensation of workmen injured in the particularly hazardous industries, including railroads. But, on the ground that it would deprive employers of their property without due process of law, including trial by jury as guaranteed by the State constitution, this act was, on March 13, 1911, declared unconstitutional.

There were presented about that time (in 1911) a deluge of Commission reports; hundreds of compensation bills were introduced in the 41 legislatures in session, and ten states passed Workmen's Compensation Acts in 1911; four more in 1912, and at least one additional in 1913, while several States modified their previously adopted plans.

Of these fifteen Acts, two (Ohio and West Virginia) only, provide that any portion of the expense is to be borne by the insured, in each case the employer being permitted to deduct 10 per cent of the premiums from wages of the workmen. In all the other States the expense is to be borne entirely by the employer. Three of the acts establish State Insurance Funds

for handling the entire compensation matter, Washington, Ohio and West Virginia. Two, Massachusetts and Maryland, provide that the compensation shall be covered by insurance in approved organizations, but leave it optional with the employer whether he shall use this plan or continue under the employers' liability laws. The ten other States, Arizona, California, Illinois, Kansas, Michigan, Nevada, New Hampshire, New Jersey, Rhode Island, and Wisconsin, have provided systems of compensation to be paid direct by the employer, but have usually left it optional with him as to whether he will come under the plan or continue to take his chances under the laws of liability, although in most cases the common law defences of assumption of risk, contributory negligence, and the fellow servant rule are abolished or greatly modified in favor of the workman.

As about half a dozen of these state laws have already stood the test of constitutionality before the highest courts, it is probable that most or all of them will stand, as their framers have been careful to avoid the rocks on which the New York compulsory law split, and that they will be followed by similar acts in the other states until the field is pretty well covered.

An effort has been made to standardize such state legislation, and three conferences have been held for this purpose. At the one in Chicago a couple of years ago, representatives of nearly all the State Commissions then engaged in formulating compensation bills agreed in a general way that such bills should be made as nearly uniform as possible, and went so far as to decide what treatment should be given each of the more important details in such legislation. But when their reports were presented to the various legislatures, not very much uniformity was apparent in their recommendations, and by modifications in the legislatures the differences were made still greater, so that the effort to establish similar conditions in the individual states seems to have come almost entirely to naught.

Nor does any action along state lines solve the problem so far as the employees of interstate carriers are concerned, for in matters of this nature they are not under the jurisdiction of the states if the federal government chooses to handle the matter for the entire country, and most of the state laws, to avoid any question of doubt on this subject, have specifically exempted interstate commerce employees from the provisions of their acts.

To cover this field, a Special Commission was appointed by the government in 1910 to "make a thorough investigation of the subject of employers' liability and workmen's compensation," and this Commission, in December 1911, presented to Congress, through the President, a draft of a compensation plan to apply to the employees of the interstate carriers. They recommended making it compulsory upon all carriers to pay men injured in the service 50 per cent of their wages (within specified limits) during their period of dissability; and varying percentages of wages to their dependents for eight years in case of men killed in the service. The maximum death benefit under the bill proposed would be $4.800, and the maximum disability benefit $600 a year, or $50 a month, continuing during the dissability.

The Commission estimated that the cost to the railroads of paying these benefits would be, on the basis of the accident experience of the three years 1908, 1909 and 1910, approximately $12,000,000 to $13,000,000 a year, as compared with a present expenditure for settlement of accident cases of about $10,000,000 a year. But others have estimated that the cost would be considerably higher than the commission's figures, perhaps as high as $16,000.000 to $18,000,000 a year.

As all the money paid out under such a plan would go direct to the beneficiaries for whom it is intended, and perhaps half the money now spent by the railroads in settlement goes into the hands of others, it is clear that the injured workmen or their families would actually get about three times as much in the aggregate under the compensation plan as they now receive under the liability laws. The most natural thing to expect then would be that the men would be clamoring for the passage of an act which would substitute for the present uncertainty, delay, litigation, and distress, a system of prompt and uniform benefits aggregating three times what they now receive. Even so late as last week Chairman Sutherland of this Commission expressed himself publicly as having no doubt the bill would be approved by the next Congress, soon to convene. He bases this prediction largely on the fact that a number of the labor leaders expressed their approval of the bill at the time it was drafted, and the Brotherhood of Locomotive Enginemen is on record as favoring a workmen's compensation plan.

But here is where a surprise is to be sprung on the unsus-

pecting country, incluing Congress and the Commission. All the other influential Brotherhoods of railway employees have had conventions in the meantime, and are now not only on record as opposed to the bill as drafted, but most of them as opposed to any bill which will take away the possibility of the occasional large awards given injured men by sympathetic juries, and give them instead the assurance of reasonable and automatic benefits for which they will not even have to ask. The natural thing would be to expect the opposition to such a plan, if there be any, to come from the railroads who would have the bill to pay. But, after all the agitation by those philanthropically inclined, after all the urging by the students of social problems and economics, that only by a uniform compensation plan could injured workers be given just and adequate assistance, come the men who would receive all the benefit and say they do not want it.

It is hardly probable that any legal way can be found to give the men what they do want—a recourse to the liability law in such cases as they feel would be productive of a large jury award, and recourse to a liberal compensation law in all other cases—nor is it probable that a federal compensation bill will be passed in the face of such nearly unanimous opposition on the part of the men most concerned. The chaotic conditions of today bid fair, then, to continue indefinitely.

I should like to be able to predict for you the ultimate outcome of the movement, but I cannot. An ideal compensation law has not yet been evolved. Paternalistic Germany, where all the conditions most favor the development of the idea, has taken the greatest interest in the subject ever since she made the start, but with all her progress there are still many defects in her plan. Perhaps the chief one is that a certain weak element among her workmen has permitted its manhood to be undermined and has stooped to malingering and falsification to keep itself on the government's compensation roll, and the government has not sufficiently exerted itself to prevent this.

No one can tell you what is the equitable relation between an employer and his injured workman. On one hand it is claimed that each industry must bear the cost of its accidents, and that the only way to accomplish this is to require the employer to pay the bill, the idea being that he will add the cost

to his selling price. It is of course readily apparent to you how difficult this would be for a railroad. Others insist that the workman should, just as he would carry any other insurance, pay a portion of the cost, so that when it comes his turn to receive accident benefits he may feel that it is an arrangement to which he has contributed his share, and that he is in no wise being the recipient of charity or "poor relief" by another name. Some insist that the disbursement of all funds should be by state or government authorities, others that this should be a duty of the employer, and there are points of advantage on each side. There are a hundred other questions, equally vexatious, which must be solved, and usually be experiment, before an ideal workmen's compensation plan can be devised. Indeed, there are many able men who insist that all those who share in the gain of an employment, whether through wages or profit, should bear their own share of the risk, each being held financially responsible as far as he is legally or equitably responsible, on the theory that men who are free contractural agents, equal in the sight of the law, should not have that relation altered in one particular by the law itself, and so they oppose a compensation plan altogether.

The problem cannot now be solved on the basis of what is ultimately right, or even just. But there is a popular demand for some sort of immediate action, and if we as citizens and as a people call loudly enough for some more experimental laws, we will surely get them. The various states, and possibly the nation, will probably try all sorts of plans and expedients until they simmer down, by process of elimination, to some one workable plan which can be made universal in its application. What that will be we cannot even guess, but it must be made up of those good features of each plan which can stand the test of time and experience, as the "survivals of the fittest," and must eliminate the many features which are now stumbling blocks lying in the path of progress.

PRESIDENT: Gentlemen, this subject is of vital interest to every employer of labor and should receive a full discussion. Mr. Garrett, having made a study of this question, is both able and ready to answer any questions you may desire to ask.

MR. GARRETT: It is a pretty dry subject, and not knowing just what details you might be interested in, I only considered

the subject from an academic standpoint in my paper, and have given you a history of the general movement. But I have with me tabulations of practically all the laws that have been passed in the world, and if there is any particular point you wish to know I may be able to tell you.

MR. R. V. WRIGHT: The speaker brought out the fact that in some states we have laws that include provision also for the carriers. I wonder if he has any information as to just how the carriers feel about it in those particular states, or how it has worked out as compared with previous conditions.

MR. GARRETT: New Jersey has such a law and the Pennsylvania Railroad is nominally working under it. What it means is that they try to settle their cases on the limits established by that law. But they do not often succeed because the employers' liability law applying to common carriers, enacted by Congress, goes over the law of the state, and while many of the employees really could come under the state law they actually get very little advantage of the compensation law of the state. There has been a tendency in all the decisions of the Supreme Court in recent years to put all men who work for interstate carriers in the category of interstate employees. Take a little railroad, all in one state, perhaps only ten miles long, yet if that branch ever ships out a car of freight into another state it becomes an interstate carrier, and its employees are employes in interstate commerce. So there is practically nobody left with the railroads in interstate commerce, so far as liability laws are concerned.

In Illinois it is left optional with the railroads to come under the law or not. A number of the roads are operating under the law. In Ohio where the funds are paid through a state insurance fund, none of the roads except one or two little switching roads have tried to come under the law. The law was revised last year making it compulsory with employers generally to settle with their men on the basis of the law, but leaving it optional with railroads, and the Steel Corporation and its roads, I am informed, are proposing to come under the Ohio law as revised, trying to settle all the cases without going to court on the basis of 50 per cent of the wages during disability or for a certain number of years after death.

MR. GARRETT: They thought they had that fixed. But

work under that law, does that prevent the employees of that road from seeking relief in the courts?

MR. D. J. REDDING: If a railroad in Ohio decides to they have been very much surprised by a recent decision of the United States District Court. The bill provided that if the employer came under the compensation law and paid his money into the state insurance fund and then proposed to let his employees settle with the state entirely, that he should be "out of it" unless it could be shown that the employer was wilfully negligent. They thought "wilfully negligent" meant that the employer personally did something—actually causing or intended to cause, the accident. But some of the insurance men said that "When you come to get a case of that sort in court you will find that means that the employer need be just a little careless to have it decided that he was wilfully negligent." Sure enough, in the first case that came before the U. S. District Court the judge decided that wilful negligence meant any negligence or carelessness in providing safety appliances, etc., and in those cases the men can take the compensation benefit from the state or if that is not suitable they can sue under the old employers' liability and the employer is left no denfse at all. So that Ohio in the last two weeks has awakened to a new view point on that subject.

MR. JEWETT COLE: I believe in Illinois most of the railroads have come under the law.

MR. GARRETT: They started to. How much they have done recently I have not heard. I was speaking with a claim agent of one of the roads lately which did, and he said they had not had enough experience to know whether they would continue under the law or not. The law was modified last year and I do not know what the situation is in the last five or six months.

MR. COLE: I understood most of the manufacturers have come under it.

MR. GARRETT: Manufacturers, yes, and manufacturers' roads.

MR. COLE: I believe the fact of putting a specific price on an arm or foot proved very popular, because that prevented a good many law suits, where all the fellow had to do was to

say to the jury. "Here is a corporation, soak it" and they generally got what they wanted.

MR. GARRETT: And they still get it regardless of the compensation law.

MR. REDDING: I understood you to say that under one of the laws, it was provided that they pay the injured employee 50 per cent of his earnings during the continuance of his disability. Is there any limit placed on the disability period?

MR. GARRETT: In some places there has been a limit of eight years, in some states six, in some states no limit at all. The Federal bill, which applies to interstate carriers, puts no limit at all to disability; but to the widow they pay benefits for eight years, and to children until they come to legal responsibility.

MR. FRANK J. LANAHAN: While the United States has passed stringent laws, isn't it a fact that in England the laws are more stringent than they are here? Absolutely no defense can be brought in at the trial by an employer of labor; and every one with a servant in the house, because liability for any damage sustained by said servant while engaged in service. I read a case not long ago of a butler whose master and mistress left the house, leaving the butler in charge. They had some sort of a celebration in the house, contrary to the rule of the master, and the butler in firing blank cartridges shot himself in the hand. The people came back and the butler entered suit and recovered full damages for the time lost, there being under the law no defense to offer. Clearly this was the injured man's own fault. He had violated the rules of his employment, had stolen his employers' victuals and liquids and had gotten himself into such a condition as to bring about the accident by careless handling of a revolver, but as long as he was on the premises of the employer and sustained this damage—his own fault as it positively was—he nevertheless, under the English law received full compensation for the injury. Another case of which I heard—was of a maid in drinking a cup of tea, in some mysterious manner loosened her false teeth, and lodging in her throat, they had to be extracted by a surgical operation. Suit was entered against her employer, and again did the law step in and full damages were awarded to the tea drinking maid with the illy secured "pearls."

MR. GARRETT: That is just what happens over there. It happens the same way in Germany. It does not pay to wear false teeth. There are a lot of just such absurd things coming up under the compensation laws in European countries. If a farmer has a farm hand and the farm hand goes out and starts to abuse the animals and the animal happens to kick him, he gets his benefits from the employer right along as long as he is sick, that is, it is paid out of the insurance funds, but the employer pays the bill in the long run.

In this country it is not so very different as far as corporations are concerned. As far as individuals are concerned few of the compensation laws apply to concerns employing less than five employees in the business of the employer. Domestic employers have always been excluded. So far as corporations are concerned, in Ohio today the law is such that practically all a man has to show to the jury is that he has been injured. No matter whose fault it was, he gets damages. I have heard of a case within the last few weeks where our people thought the man had not even proved that he had been injured, but he got benefits just the same to the tune of about $5,000.

MR. REDDING: They have always had a lot of professional jurors in Ohio. When a railroad man is injured and the road has a connecting link into Ohio, the case is almost invariably taken to that State. Is there any fixed limits to the proportion of earnings to be compensated for under the Ohio law?

MR. GARRETT: 66 2-3 of a man's wages, with a limit of something like $12 a week for maximum benefits.

MR. LANAHAN: What is the exact status of the liability law in Pennsylvania? Are there no defenses?

MR. GARRETT: The law has not been changed in the last few years. The Commission proposed a law with two parts; the first removing all these defenses of the employer, and the second to provide an optional compensation plan. But that law did not pass. As it stands, corporations have still a little left of the old defenses.

MR. LANAHAN: Is contributory negligence still a defense?

MR. GARRETT: So far as I know it is.

MR. LANAHAN: I would like to relate a little incident

and know the status of the law on it as it now exists. Two working men employed by a large corporation, engaged in a fight over their work, one threw a piece of machinery at the other. Where does the liability come in there?

MR. GARRETT: If that had been in Ohio I could tell you. I am not positive in Pennsylvania.

MR. LANAHAN: I understood contributory negligence had to an extent been modified by the previous legislature in Pennsylvania.

MR. GARRETT: Yes, but it is not entirely wiped out. If a man cuts his hand by intention he gets nothing in Pennsylvania. In theory those defenses still stand in Pennsylvania, I believe.

MR. LANAHAN: There is no question about the tendency of the times in connection with liability insurance, and personally, I think it is a very good move. While it is a hardship in a great many cases and an injustice to the employer of labor, as some of the laws are compiled, nevertheless, it modifies the feelings of the employees toward the employer, and to a great extent establishes the spirit of co-operation. Furthermore, with a settled amount of renumeration established, the employer has some basis upon which to make payment for injuries instead of the problemtical manner springing from the awards of the average court jury. To the employer it saves the legal expense and oftentimes the technical delays that are incidental to trials of this kind. The delay in putting liability laws on the statute books should not be countenanced by right thinking business men for if laws that are equitable to the employee as well as the employer are not adopted there will come a time when it will be far worse to the employers, and the sooner we make up our minds to accept with a smile instead of a grimace, the drastic compensations laws, I think it will be the best thing for all concerned.

MR. GARRETT: That is true from a certain standpoint. But I am not sure that we will gain anything very lasting by it. The old employees familiar with these old conditions would appreciate the change brought about by a compensation law which is universal and automatic. But as the young fellows come up they are bound to come up into conditions just as they stand. They do not know anything about the old conditions.

It will not make them feel any better toward their employers to have a compensation law. The causes of strife between employer and employee are not those that compensation laws would change.

MR. W. V. TURNER: Our friend to the left struck what in my judgment is the key note of this whole situation. I believe that it is immaterial to the employer what compensation laws he has to comply with or what wages he pays, or, in fact what expense he goes to in any way, shape, or form, provided it can be added to the cost of his product, which, however, can only be done where laws compel uniformity. But I do not see how either the employee of a railroad or of an other corporation can expect to get blood out of a turnip. If they expect compensation, and also wages, they must provide in some way that it gets into the corporation before it can come out.

Take the present situation in regard to the railroads. Mr. J. J. Hill expressed it very well when in reply to a proposed bond issue with which to buy new cars he remarked, "If you will not permit us to obtain the money with which to build new cars build them yourselves and we will haul them for you." It is exactly this way with regard to either wages or compensation in any of its various forms. It must be added to the cost of the product before the employer can pay it out. If either ourselves or the public in general desires service in any form, we must be willing to pay for it. And until the people as a whole will permit the railroads to in some way compensate themselves for increased cost of labor, material, taxes, interest, and increased cost of a thousand and one other things, they are going to get worse service, and we are not going to be able to keep up with the demands of the times.

It is exactly the same with this effort on the part of the employer to give and of the employee, to obtain, disability compensation. It may be that a few firms or corporations are so situated that they have rather more than less to say as to what shall be the price of their product but such concerns are few and far between. With most of them, prices are fixed on the basis of competition, or supply and demand, but there are some, with which class we are now concerned, namely, the railroads, who have no voice whatever in what the selling price of their product shall be. Yet, apparently, they are expected to be in

the same position to build additional track, maintain a most exacting and luxurious service, pay an increased price for the material of other concerns, be subject to an increase of wages on demand, work out compensation schemes, etc. without calling upon the public for assistance. They are supposed to be like unto the widow's vessel of oil, the more you take from it, the more it contains. Other concerns have no one to say that they must haul a ton of freight two miles and a half for the price of a postage stamp, or one person and four tons of car for two cents per mile, which is at the rate of one-half cent per ton mile. Consequently, it will be seen that some concerns are in a far better position that others to consider the workman's compensation act, irrespective of whether or not a law reuires its adoption, while others are in no such position until a uniformity of laws compel competitors to include this added cost of production. For example, suppose we have a workman's compensation act and other employers responsibilities added to the cost of production in Pennsylvania with none in adjoining states, it will be clear that the employer in Pennsylvania could not add the increased cost to his selling price, and therefore his business must gravitate to the adjoining states, either by his removing it there bodily, or by his competitors taking it from him. So with everything that costs more to produce in one state than in another, the business will gravitate to where the product can be produced the cheapest, provided it cannot be sold for the increased price where it is produced. Therefore, with regard to these compensation acts, it is essential that in every state the laws be uniform, that is, that they impose a uniform burden as far as they themselves are concerned upon the employers, if there is going to be freedom of competition among manufacturers. Certainly, with the railroads it should be uniform. Just think of adding $16,000,000 in the form of compensation outgo to the railroads without it being in the power of the railroads to get a solitary cent with which to meet it unless through the consent of a third party, which I am sometimes inclined to believe flirts with the idea that something can be had for nothing. Perhaps it is public opinion that reflects this idea, and others catch the reflection, but until public opinion, if this is so, will permit of the railroads realizing a fair return for their service, payment of interest, increases of wages, and power to borrow

for purpose of expansion, will be impossible, and I do not see how the workingman of this country can expect the railroads, or any other concern for that matter, to give them even temporarily, or continuously, 50 per cent of their wages for disabilities, until it is first possible for them to obtain the wherewithal. I feel reasonably sure that no one desires in a greater degree than myself that every man should have everything requisite to satisfy his needs and as much more as he can legitimately obtain, but a desire in this direction is not sufficient. It is first necessary to have the means, but this means can never be distributed on a uniform basis; in fact equality of distribution for service demands that it shall not be; for the man who by exceptional ability can provide work for many others is entitled to and must receive, if he is to be fostered, a fair reward for his services, and the thought that has been spread abroad, that to take away from these men the difference between what they get and what some others of less ability or opportunity receive and distribute it uniformily among all, would supply every one with what they need, is a very dangerous and pernicious fallacy and would result, in the last analysis, in taking away from those who need that which they now have.

There are two things of which the people as a whole must be convinced and accept before some of the things which the opportunist and others promise them can have any possibility of realization. One of them is that, when what is proposed has finally simmered down, what they get must come out of the whole people, and the other that it must be by means of a federal law; a uniform law; a law that bears equally upon all, which may mean that it must bear upon some differently than upon others, that is, allow for other handicaps. Until these two things can be accomplished, whatever is attempted must be more or less chaotic. It cannot be accomplished permanently and will only be an attempt to do justice to some at the expense of others, which, as I understand it is not the workingman's desire. There is no manufacturing concern or railroad, with such an unlimited store of money that they can satisfy the constantly increasing demands without what they have to pay being added to the cost of their product, nor can they compete where in one state there are laws as stringent as some people would make them with a state where they do not exist at all. Consequently the

people as a whole must wake up to the fact that they are the ones that will have to contribute in the last analysis all that is paid out; that the whole question simply resolves itself into the fact that those who are fortunate must take care of those who are less fortunate, and this is quite a feasible and proper provision, but it never can be accomplished as long as some desire it at the expense of others.

MR. GARRETT: The government commission on compensation is a pretty fair minded lot of men. Senator Sutherland, the head of it, is an especially broad minded lawyer. The provision in their bill was this reading: "That it is hereby declared to be the policy of Congress that the burden of compensation under this Act for personal injuries shall be considered as an element of the cost of transportation, and the Interstate Commerce Commission in any proceeding before it affecting rates is directed to recognize and give effect to this policy." But, the very first thing that happened when the bill was introduced was to scratch that clause off the bill, entirely.

MR. CHARLES A. LINDSTROM: What is the object of this legislation?

Is it not to take care of a man and his family when he is injured?

Is it not up to those who are well to take care of those who are sick, no matter whether by accident or otherwise?

I think every man who is working and is well should help to pay not only for the sickness of others but also for himself. The injured have a right to be taken care of without being sent to the Poor House, and the family should also be taken care of. How that is to be done must be worked out in the future, but it is bound to come sooner or later.

I do not think, however, that it is fair to put such burdens on the manufacturers alone. In the case of a great calamity in a small business, for instance, the total number of injured or killed may be so large that if the manufacturer had to take care of them himself, the firm would be ruined and it could not be done. I have always been of the opinion that there should be a national savings fund, to which every man from the time he begins to earn any money should contribute a certain percentage, to be held either by the state government or the national government and from which he could draw in case of sickness not

only fifty per cent of his salary but one hundred per cent of his salary, and in case of death his family should be compensated and taken care of as long as they require such aid. I think the time will come when this will be recognized as the only correct principle of human treatment.

MR. J. C. WARNE: I have listened with a great deal of interest to what has been said. There are some things which it occurs to me ought to be emphasized. One is how we are behind European nations in regard to the matters we are talking about tonight; I agree with the sentiments expressed by Mr. Lindstrom. Two years ago I traveled in England and through the courtesy of an official I was invited to go through a large car manufacturing plant. Incidentally this very question of compensation came up, and I said "How do you do when fellows get hurt?" Well he said the compensation law takes care of them. I said "In what way?" He replied "If a man gets hurt even by his own carelessness it makes no difference, we have to pay half his wages as long as he is hurt. That is settled by law. We can't get out of it." I said "That is much ahead of what we have in America." He said "That is the new law. We can't dodge it. No matter if a man purposely injured himself he can always put up a good yarn that it was done some other way and we do not consider that at all, we just pay him. That is all we have to do."

The other question is about insurance. They have now what they call national insurance. For every man that works for an employer the employer has got to pay 7 pence per week to the Government. Out of that the employer is compelled to pay 3 pence and the employee 4 pence. If a man falls sick from any cause a certain sum is paid by the government to him. Another way in which they are ahead of us is in what they call old age pensions. When a man or woman reaches the age of 70 they are paid 5 shillings a week each as long as they live. So in three matters they have got much more help there for poor people that we have, the compensation law, the national insurance and the old age pensions. They have had old age pensions in New Zealand for many years. I think they were the first to start it. They take care of their injured and poor in a different way from the work house and poor house way. Take an old man and his wife with 10 shillings a week between them and

they can get along pretty well, and it is not charity. That illustrates how these ideas are coming to us, and legislation of this character is bound to be adopted in our country in the near future.

MR. REDDING: In any of the states where laws have been passed has a provision been made for the fellow that hasn't got a job?

MR. GARRETT: There have been a good many provisions made in Europe carrying out the idea you have just suggested. They have the so-called "unemployment insurance." None of the states in this country have attempted that as yet. A great many organizations are talking about it and drafting bills to cover unemployment, but it is only possible to carry out a scheme of that sort where you have free public employment bureaus, where a man when he gets out of work can go to the Board and say "I want a job" and they must either give him a job or give him wages while he is out of work. It would be pretty hard to apply in this country yet, but it may come after while. They have it in several countries in Europe.

MR. W. D. SMOOT: What if anything has been done in the way of compensation for what is known as occupational diseases?

MR. GARRETT: I have not studied occupational diseases and those questions very much, but in Illinois they have passed an occupational disease law which puts a certain list of occupational diseases in the same category as industrial accidents, and there is a movement to make that as universal as the compensation law will be after while. So far I think only four or five states have attempted to pass occupational disease laws. And that is another thing that we might just as well mark down as coming. Because if you hire a lot of men in painting cars, and they paint with a spraying machine and a certain proportion of them are taken with lead poisoning every year, as we know they are always doing, that is just as much an occupational accident as if a man hits himself on the hand with a hammer. I do not know much about the Illinois law, because I have had no occasion to study it.

MR. TURNER: I would like them to figure out with regard to the compensation, where it finally comes from; where the money for these things is to be obtained. It is self-

evident that we cannot obtain something for nothing. This is my sticking point, but a good many working men with whom I have talked on the subject, seem to think that everything can be promised without this being a consideration. In fact, some seem to think what is required may be pulled out of the atmosphere as the necromancer pulls out coins.

MR. GARRETT: Mr. Turner answered that question himself a while ago as well as anybody can answer it. He has been talking about that very thing for ten or fifteen minutes and telling you that it can not come out of the air, and now he asks you where it can come from. An interesting thing about that has been developed in the discussion. In the state of Washington they have a state insurance fund in which each class of employment forms a separate fund. That is if they had a lot of car factories, the car factories would be considered in one branch. The lumber dealers would form another, and each one would have his premiums graded each year on the basis of the accident experience of the year before in that particular line, and all of them in that line would pay in the same premiums regardless of the number of accidents they had in their own individual plants. There has been a lot of objection to that, because the man who has a safe plant has to pay the same premiums as the man that has a very poor plant where some one is being hurt all the time.

The payment of a per cent of the wages into the insurance fund makes a burden upon the employer coming under the compensation law, as compared with employers in states where they have no compensation laws and that has been the basis for agitation for uniform laws. The commissioners from the various states have got together different times to talk that over, and they went through all these objections from one end to the other. But when the commissioners get back home each one tries to figure out something a little better for his own state than the other fellow, and it comes back to the same old basis that there is nothing accomplished in the way of uniform laws. And there will not be as long as the whole matter is subject to the whims of state legislatures.

MR. TURNER: No one has figured out just how they are going to get this money except out of the cost of the article.

MR. GARRETT: The general theory is of course that each industry should pay the entire cost of the production of

the things which it turns out. Part of the cost of the production is the lives and limbs of the men who are making it. And the theory is that the industry should pay all that and put it into the selling price that you and the other consumers pay for the thing you are getting. That is all right in theory, but unless you apply it universally it will never work out in practice, because it simply means that the profits of the man that has to pay the benefits are going to be less than those of the man who does not have to. Some states have actually turned down the whole proposition for that reason, that they will lose what advantage they have over other states around them.

MR. TURNER: That is the very point I want to get into the record for the whole system of compensation turns on the realization of that very thing.

MR. C. E. POSTLETHWAITE: The statement is made that the money is included in the cost of production. If we go a little further and examine carefully all this agitation of the present high cost of living we will find that each one of us contributes our share of the expense. The public demands and the public pays. We are part of the public. We should therefore, as has already been suggested, take a live interest in this and all other similar questions of the present day. To my mind provisions of this kind are wise and timely but they should be handled cautiously in order that the results may be efficient with the deserving, but avoid the possibility of making an already improvident man more improvident.

MR. LANAHAN: Mr. Garrett, you have given considerable thought to this subject. Will you tell us what state in your estimation now has the best compensation law, that works most satisfactorily to all concerned, employer and employee alike, and have you a synopsis of that law?

MR. GARRETT: That is not an easy one! I would like to think of a real good answer to that—but there isn't any. It all depends on the view point of the one who answers that question. I do not think any one state law can be said to be better than the others, because some of the state laws are better in one particular and others in another particular, and they do not average up anything alike. At the same time all of them have so many defects that you can not say there is any good compensation law now. Perhaps the state of Washington with

the state insurance fund has the one that is most satisfactory in its workings, but the division of the cost is not equitable, and there has been a great deal of dissatisfaction on that basis. I do not think I could answer that question any further.

MR. LANAHAN: Has a compensation law been passed that is satisfactory to the labor unions? You spoke a while ago of the Brotherhoods objecting to the federal Act that was suggested by Senator Sutherland. Have any of those laws of Ohio or Wisconsin or Illinois, etc., been acceptable to those organizations?

MR. GARRETT: Most of the state compensation laws that have been passed have been acceptable to the labor unions, that is the ordinary labor unions, but not to the unions of high class, high paid men. Their restriction of benefits to $12 or $15 a week for accident benefits is too low to make it acceptable to men making $150 or $200 a month. Otherwise most of the compensation laws have been acceptable to the labor unions.

MR. LANAHAN: The main difficulty is in getting such a large body of men as composes the average state legislature, or even the law giving body at Washington, to give the proper consideration and thought to the subject as sweeping in its scope as working men's insurance, and I have heard it said that under the old law 40 per cent as the minumum went to the legal fraternity for collecting damages, and many of these gentlemen by virtue of political activity were in the courts as well as the state legislature and with illy concealed antipathy were opposed to having any measures put through in the shape of laws that would take away such a large share of their lucrative products. That such measures becoming laws would prove beneficial to employer and employees alike, or bring a better understanding between capital and labor is entirely lost sight of in their spirit of selfish aggrandizement upon the part of the law makers.

MR. GARRETT: I do not think we had better discuss that very far. It is too patent a fact.

PRESIDENT MITCHELL: Does any one else wish to speak or ask any questions? If not, Mr. Garrett will close the discussion.

MR. GARRETT: I do not think I have anything to add to what I have already said.

MR. LINDSTROM: Mr. President and gentlemen, I do not remember a time when I have listened to a more interesting paper than we have had before us this evening, and I would suggest that you join me in a rising vote of thanks to Mr. Garrett for the valuable information he has given us.

The motion was duly seconded and carried by unanimous vote.

PRESIDENT MITCHELL: Mr. Garrett, you will please accept the thanks of the Club.

MR. GARRETT: I thank you, gentlemen.

ON MOTION? Adjourned.

J. B. Anderson
Secretary.

NOTE: The following remarks were submitted after adjournment by Sion B. Smith, Esq.

In answer to Mr. Warne's question as to why we in the United States are so far behind European countries on this question, the explanation is simple—to a lawyer. European countries are monarchies. The king can do what he pleases. In this country we work under a Constitution. We can not do anything forbidden by the Constitution until we amend the Constitution allowing such act. And amending the Constitution is a very long, tedious and difficulty operation. Our Constitutions, both state and national, safeguard the right of trial by jury and provide that ones property shall not be taken from him without due process of law. Therefore a law which undertakes to say that an employer shall pay his employee upon the mere happening of an accident, denying to him the right to have a determination in court as to whether he is liable for the damages, is contrary to the Constitution. On this ground the courts have in a great many states held compulsory compensations laws unconstitutional. And that is the reason why efforts in this state fifteen or twenty years ago to get a compensation law failed.

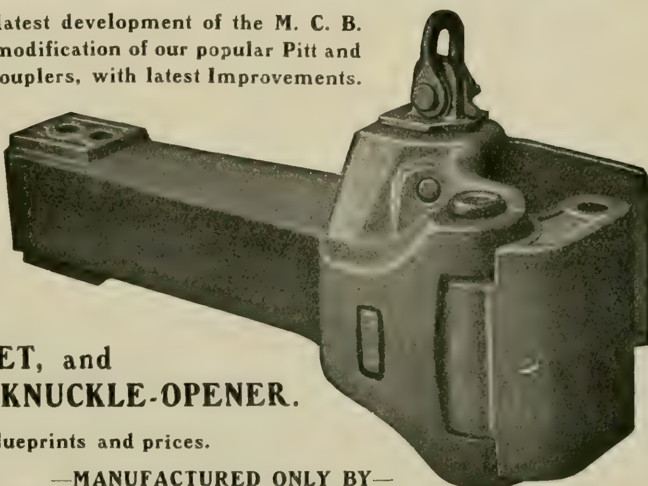
The plan that has so far been adopted to get around this difficulty is to make the compensation law optional with the employer, but take away from him the three technical defenses of contributory negligence, the risk of the employment, and the fact that the injury resulted from the act of a fellow servant. He has the delightful choice of swallowing the compensation law or going into court stripped of substantially all his defenses and at the mercy of the jury.

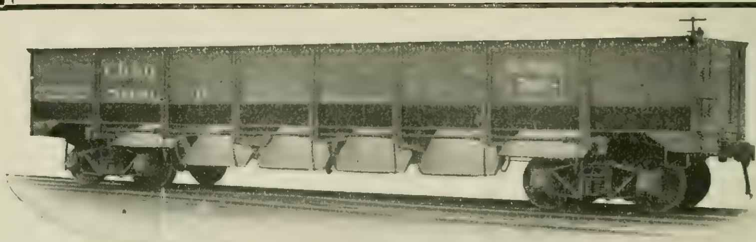
In Memoriam

J. McANDREWS

DIED

MARCH 16, 1913





OFFICIAL PROCEEDINGS OF

RAILWAY CLUB OF PITTSBURGH

$1.00 Per Year — 20¢ Per Copy

Vol. XIII. DECEMBER 18, 1913 No. 2.

Locomotive Boiler Design and its Relation to Capacity

By Mr. A. W. Whiteford, New York, N. Y.

INDEX—ADVERTISERS.

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F. R. McFEATTERS.......................November, 1910, to October, 1912.

* Deceased.

Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, DECEMBER 18th, 1913.

The meeting was called to order at the Monongahela House, Pittsburgh, Pa., at 8 o'clock P. M., by President A. G. Mitchell.

The following gentlemen registered.

MEMBERS.

Amsbary, D. H.
Anderson, J. B.
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Barth, J. W.
Battenhouse, J.
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Harriman, H. A.
Haselett, D. H.
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Mensch, E. M.
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Mitchell, A. G.
Mitchell, H. T.
Miyasaki, Y.
McCann, J. P.
McCauley, Wm.
McCollum, G. C.
McKinstry, C. H.
McNulty, F. M.
Neal, J. T.
Neff, John P.
Newman, L. L.
Peach, W. M.
Pearson, A.
Pehrson, A. K.
Pratt, I. D.

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Richardson, L.	Trappe, W. C.
Richardson, W. P.	Tucker, J. T.
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Scheck, H. G.	White, F. L.
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Smith, M. A.	Wyke, J. W.
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Hutchison, L. A.	Whiteford, A. W.
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Miller, B. W.	Wilson, T. A.
Mitchell, J.	Williamson, J. A.

Yawman, C. A.

The calling of the roll was dispensed with, the record of attendance being had through the registration cards.

The reading of the minutes was dispensed with, the same being in the hands of the printer and about ready for distribution.

The Secretary read the following list of applications for membership:

Amend, Geo. F., Motive Power Inspector, P. R. R., 100 Elm Street, Edgewood Park. Recommended by J. B. Anderson.

Curtis, Wm. R., Draftsman, Jones & Laughlin Steel Co., Errett Place, Carnegie, Pa. Recommended by C. H. Reymer.

Deagen, John J., Blacksmith Shop Foreman, Penna. Co., Lines West, 1207 Center Ave., Wellsville, Ohio. Recommended by D. W. Fitzgerald.

Henry, J. M. Superintendent Motive Power, P. R. R., 207 Penna. Station, Pittsburgh, Pa. Recommended by J. B. Anderson.

Hetzel, Edward J., Clerk, Oliver Iron & Steel Co., South 10th & Muriel St., Pittsburgh, Pa. Recommended by C. H. Reymer.

Holt, James, Piece Work Inspector, P. R. R., Pitcairn, Pa., P. O. Box 284. Recommended by J. H. DeArment.

Hutt, Frank, Salesman, Midvale Steel Co., 1630 Oliver Building, Pittsburgh, Pa. Recommended by James Booth.

Loughner, M. F., P. W. Inspector, P. R. R., 605 Walnut St., Irwin, Pa. Recommended by Carl Rivinius.

Malone, W. R., Draftsman, P. R. R., 453 Third St., Pitcairn, Pa. Recommended by I. D. Pratt.

Pittenger, Howard L., C. C., M of W. Department, Penna. Lines West, 713 Morth St., East Liverpool, Ohio. Recommended by D. W. Fitzgerald.

Sarver, Gilbert E., Assistant Foreman, Penna. Lines West, 1448 Columbus Ave., N. S. Pittsburgh, Pa. Recommended by W. T. Schomberg.

Schultz, Wm. A., Boiler Maker Foreman, Penna. Co. Lines West, Broadway, Wellsville, Ohio. Recommended by D. W. Fitzgerald.

Smead, D. N., Draftsman, P. R. R., 453 Third St., Pitcairn, Pa. Recommended by I. D. Pratt.

Tarran, Lester H., Draftsman, P. R. R., 6403 Dean St., Pittsburgh, Pa. Recommended by I. D. Pratt.

Trueb, Edwin, Draftsman, P. R. R., Trafford, Pa., P. O. Box 183. Recommended by I. D. Pratt.

Wagner, C. W., Inspector, Penna. R. R. Co., Room 301, Second National Bank Building, Pittsburgh, Pa. Recommended by A. C. Cotton.

PRESIDENT MITCHELL: As soon as these applications have been approved by the Executive Committee, the gentlemen will become members.

If there is no further business to come before the Club, we will listen to the reading of the paper of the evening by Mr. A. W. Whiteford of the Jacobs-Shupert United States Firebox Company on the subject "Locomotive Boiler Design and its Relation to Capacity."

LOCOMOTIVE BOILER DESIGN AND ITS RELATION TO CAPACITY.

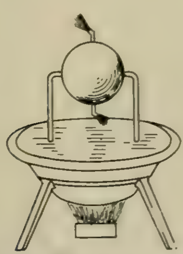
By A. W. Whiteford of New York.

Locomotive Boiler Capacity for any given service is determined by the cylinder demand. Cylinder demand is in turn determined by the weight of the load to be hauled, the tractive effort necessary to start it, and the speed with which it is to be moved.

The history of boiler development from its earliest inception down to the present is practically one consistent record of an effort to increase the capacity.

This development has been rather more periodic than continuous. Long spells of activity have been followed by long periods of rest which have again in turn been followed by renewed activity. We are at present in the midst of one of the active periods.

The first man to develop anything in the nature of a device that utilized the power of steam was Hero of Alexandria. He lived about 150 B. C. He was known as quite a philospher and investigator in his day, and he left some works on pneumatics that are still in existence.



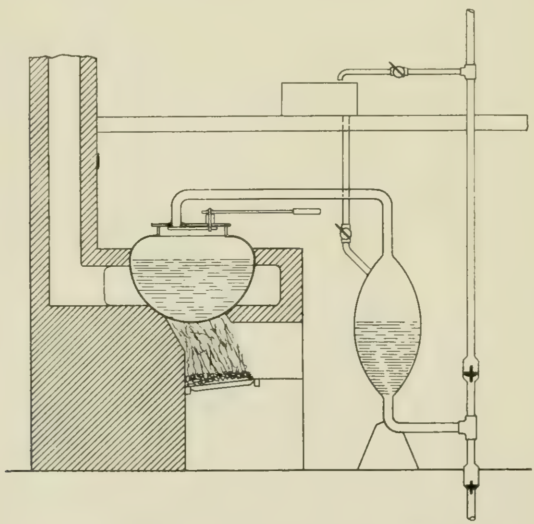
The first steam engine.
Hero of Alexandria, 150 B. C.

His steam engine consisted of a small hollow ball set in a frame work above a vessel equipped with a tallow burner. This vessel was constructed so that it could be filled with water, and after the wick was lighted long enough the water would boil, and the steam would rise through a hollow pipe that entered the ball through one of the pivot joints. At

two opposite points in the ball, openings were arranged out of which steam could flow, and the reaction of the escaping steam kept the ball in motion. This was really nothing more than a toy, but for over seventeen hundred years it was the only steam engine known to the world.

About 1543 a Spanish sea captain, Blasco de Garay, probably discouraged by the many delays he had suffered from calms, made an effort to develop some sort of a steam power device with which to move his boat, but he was unable to leave much more than a record of his efforts. His work, however, resulted in further attempts along this particular line of development.

By 1600 the French, the Italians and the English were all busily engaged in making efforts to solve the problem. Between 1600 and 1663, two Italians, Giovanni della Porta and Giovanni Branca, Solomon de Caus, a Frenchman, and the Marquis of Worcester, an Englishman, had all developed efforts of sufficent importance to be recorded. Their devices, however, were little more than failures, as none of them ever became permanent.



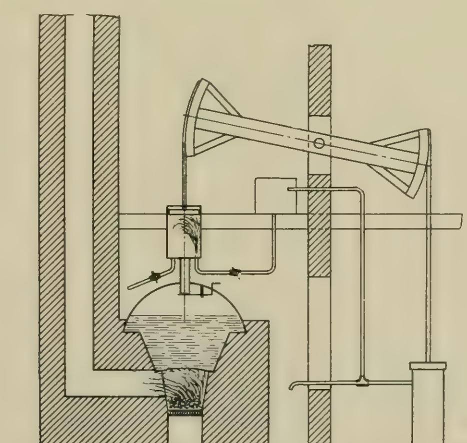
Savery's pumping engine, 1698.

The trouble with them all seemed to be that no one ever thought of a method to regulate the pressure of the steam in the boilers. They were built either with a plain open spout so that the water

boiled away, or they were entirely closed, and in time the pressure would blow them up.

About 1675, a Frenchman, Denys Papin, who had been exiled to England, conceived the idea of building a boiler with a small door that could be opened or closed with a spring, and thus relieve the pressure when necessary. He truthfully can be recorded as the original "Safety First" mechanical man, and from his idea was developed what we now know as pop or safety valves on all boilers. From then on the development rested largely with the English and the Scotch. The chief industry at that time in England and especially in Cornwall, was the mining of coal. As at present, one of the difficulties was the keeping of the mines free from water. In 1698, Savery, a mining engineer, rigged up a boiler connected by piping to a closed vessel. Steam was admitted to the vessel by hand and, upon condensing, the vacuum which was formed, opened a valve and lifted the water. Steam was then again admitted to the vessel and the water was forced out by the steam pressure. This was the first actual recorded use to which the power of steam was ever applied. Savery's trouble was lack of practical shop knowledge, and his engines were not always satisfactory.

In 1702, Newcomen, a blacksmith and a mechanic, who had

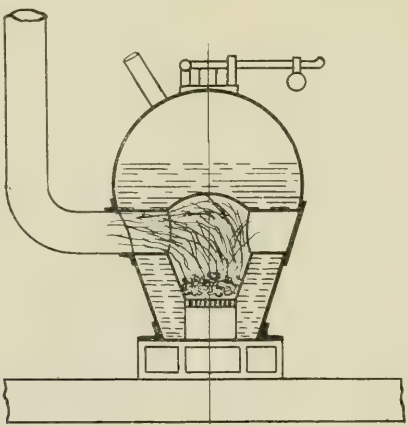


Newcomen's engine, 1702.

done a lot of work for Savery, conceived the idea of a cylinder and of attaching a piston rod to a beam at one end, and applying

a heavy weight to the other. When the piston was in the right position, steam was turned on which pushed it up and held the beam down. The steam was then allowed to condense, which created a vaccum in the cylinder, which with the weight on the other end of the beam returned the piston to its original position ready for another stroke.

In time some one conceived the idea of injecting cold water into the steam to more rapidly condense it, but on all of the designs the inlet and outlet valves, were regulated by hand and it was almost impossible to build an engine that would run at the rate of more than sixteen strokes a minute. In a great many of these engines the cylinders were quite large, some of them over 72 inches in diameter, but the pressures were low and they all depended on the condensing of the steam in the cylinders to enable them to work. No one had yet thought of an exhaust, and for over fifty years no changes or improvements of any importance were made from Newcomen's original idea.



First internally fired boiler.
Smeaton, 1740.

In the meantime, Watt appeared on the scene. This was about 1760. To him we owe the greatest development of the steam engine. The first thing he did was to let the steam escape after it had done its work, and condense it in a separate chamber. From that it was but a step to the guide and piston and the cylinders closed at both ends. Boulton worked with Watt and Murdock followed them very closely. The two

Trevithicks, father and son, were also adding their efforts along about this time, and from then on the development was much more rapid.

The first man to apply the power of steam to a moving vehicle was Cugnot of France in 1769.

The first traveling engine in England was that built by Trevithick who carried people in 1801 and Wm. Hedley brought out "Puffing Billy" in 1813.

Geo. Stephenson developed his first locomotive in 1814 and kept on improving his idea until he brought out the "Rocket" in 1830. In 1836 he brought out a second locomotive, the general type of which has been a standard ever since.

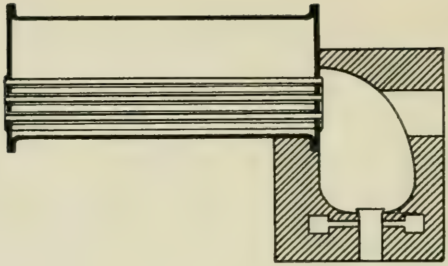
One great trouble in the early stages of the development was that it was impossible to get the machine work done that was necessary. For instance, Watt once wanted a cylinder, but there was no machinery in existence that could bore it the way he wanted it, so he had to have one hammered out by hand. One report in his biography says that one of his chief troubles was that he couldn't get his work from the "smith" shop. This sounds like a somewhat familiar complaint to the average railroad shop man.

The original boilers as first built were nothing more than kettles or large drums filled with water and placed in position over a fire.

The first man to surround the fire by water was Smeaton, an Englishman, who in 1740 built a boiler with the furnace in the center. Some years later, Trevithick, Sr., and Evans, an American both built cylindrical boilers, and carried one single flue all the way through the boiler.

About 1791, Nathan Read, another American, conceived the idea of splitting the smoke up into channels, and thereby developing what has since been known as an upright or multi-tubular boiler.

Neville and Trevithick, Jr., also had similar ideas, which they afterward developed. These boilers were all upright. This was about 1800 to 1820.



The first multi-tubular boiler.
Seguin, 1828.

About 1828 Seguin, a Frenchman, constructed the first horizontal multi-tubular boiler and this type of boiler has ever since been known as a "locomotive" boiler. This design enabled the weight to be more evenly distributed, and the capacity to be greatly increased on account of the increase in heating surface.

Stephenson's "Rocket" was built on this plan, and for more than sixty years, with the exception of an increase in size and weight, no very pronounced change of any kind was brought about in this type of boiler. In the early nineties the "wide" firebox made its appearance and from that date has been one of the periods of greatest activity in locomotive boiler development.

Although in the period from 1830 to 1890 no very pronounced change had been brought about in the general plan, still certain facts had been practically established in regard to locomotive construction and certain well known principles had been laid down and were being very generally observed.

These facts had to do with various features of boiler design, heating surfaces, cylinder proportions, etc., many of which had been worked out by actual tests under working conditions.

In 1830 Stephenson found that in a locomotive boiler, open to the atmosphere, and with the firebox separated by a plate from the barrel, that one foot of firebox was equivalent to three of tube surface. In 1840 Dewrance modified the experiments by dividing the barrel of a small locomotive boiler into six compartments that next the firebox being 6 inches long, and the remaining five compartments each 12 inches long. The results showed that the first six inches of tube were equal, area for area, to the firebox surface; the second compartment was only about

one-third as effective, while in the remaining four compartments the evaporation was so small, according to the experiments, as to be practically useless.

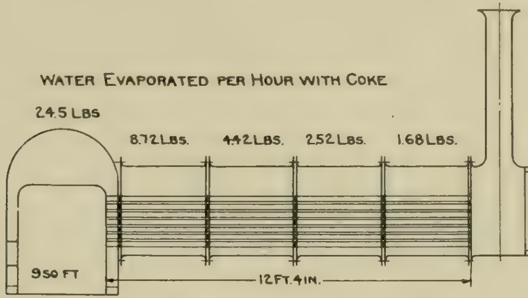


Diagram of boiler used in Petiet tests, 1865, showing water evaporated per hour in each section of the boiler.

In 1858 C. W. Williams experimneted on a small open topped boiler, 4 feet 6 inches long, having a 3 inch tube passing through it. The boiler was divided into five compartments, the first being 6 inches and the others 12 inches in length. The heat was supplied by means of a gas burner in one end of the tube, bent down at a right angle. In a trial of four hours the water evaporated from 44 degrees was in the five compartments respectively 96, 44, 24, 19 and 16 ounces, and although the temperature of the escaping products of combustion was about 500 degrees, that of the water in the last compartment was only 170 degrees.

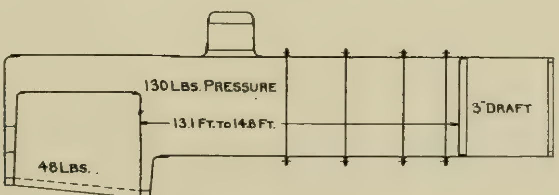


Diagram of boiler used in Henry tests, 1890, showing steam pressure, grate area, draft, and proper flue length.

Petiet in 1865 divided a boiler into sections and ran conclusive tests to prove the evaporative value of various portions of the heating surface. He was Supt. Motive Power of the Northern Railway of France and the figures he established are

still quoted as authoritative. His tests showed that the firebox evaporated fifteen times as much water as the forward section of tubes.

In 1890 another Frenchman, Henry, Supt. Motive Power of the Paris, Lyons and Mediterranean Railway, conducted an elaborate series of tests to try to establish figures showing the proper length for flues. These tests are referred to quite extensively by C. D. Young, Engineer of Tests of the Pennsylvania Railroad, in paragraph 60-65 of his report of Tests of an E-6 Locomotive completed last April.

The report of the Committee on "Relative Proportions of Cylinders and Driving Wheels to Boilers" for the Master Mechanics Association in 1888 recommended the following proportions for engines with a 24-inch stroke.

Total H. S. = Piston Area in inches $\times$ 5.8
Total H. S. $\div$ 11 = Fire Box H. S.
Total H. S. $\div$ 70 = Grate Area
Total H. S. $\div$ 400 = Flue Area.

This represented practically the adopted practice for what we today would class as the "narrow firebox" or standard engine.

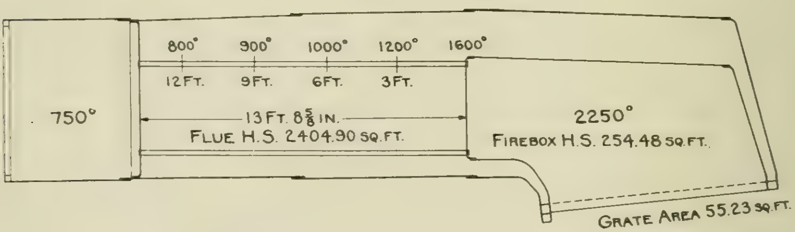


Diagram of Class E-6 boiler used in Penna. R. R. tests.

By 1897 the wide firebox was becoming so well established that a new set of ratios was worked out by a Committee of the M. M. Association. These ratios related to Grate Area, Heating Surface and Cylinder Volume, and have ever since been referred to as the '1897' specifications. This Committee reported as follows: "Your Committee could find no available data on the relative value of firebox heating surface and tube heating surface, some authorities claiming that the former was worth twice as much, and some ten times as much as the latter. It will be seen to average about 100 per cent of the total heating surface."

In 1902 the Master Mechanics' Committee reported as follows: "The important relations in boiler design are those between the power and total heating surface, between the total heating surface and grate area, and between the power and grate area." Also "the ratio between tube heating surface and firebox heating surface is of no particular value, as grate area controls it to a large extent."

By 1903 a question had again been raised on this subject of Ratios, the report for that year reading as follows: "There is a question among some officials, that while we have ample heating surface, it may not be in the right place; or in other words, it is possible that we have too much heating surface in the wrong place; that is, are there not too many tubes used, and would not a boiler furnish an equivalent or higher evaporation with a lesser number?"

The following table shows the variation in the ratio of firebox heating surface to total heating surface between narrow firebox boilers and wide firebox boilers.

NARROW FIREBOXES.

(Compiled by H. H. Vaughn.)

Type	Cylinders	Firebox Heating Surface	Total Heating Surface	Grate Area	Percent of Firebox to Total Heating Surface
2-8-0	20¼x28 in.	212	2169	32.5	10
2-0-8	21 x30 in.	230	2682	33.5	10
4-6-0	17 x34 in.	139	1579	27.0	9
4-6-0	18 x24 in.	150	1815	27.0	8.5
4-6-0	18 x26 in.	179	1729	24.0	10
4-6-0	19½x30 in.	202	2159	32.5	9.3

WIDE FIREBOXES.

Railroad	Type Engine	Cylinders	Firebox Heating Surface	Total Heating Surface	Grate Area	Percent of Firebox to Total Heating Surface
B. R. & P.	4-4-0	20¼x26 in.	194	2992	54.4	6.4
C. R. I. & P.	2-8-0	28 x30 in.	260	4264*	63	6.1
C. P. R.	0-6-6-0	20 x26 in.	185	2949*	59	6.2
A. T. & S. F.	2-10-2	19x32x32 in.	216	4306	58	5.0
B. & A.	2-6-6-2	20½x33x32 in.	185	5476	56.5	3.3
B. & A.	2-8-0	23x32 in.	185.6	3474	56.5	5.3

* Superheating—Surface **not** included.

DIMENSIONS OF WIDE FIREBOX ENGINES

(Master Mechanics' Association Proceedings 1903)

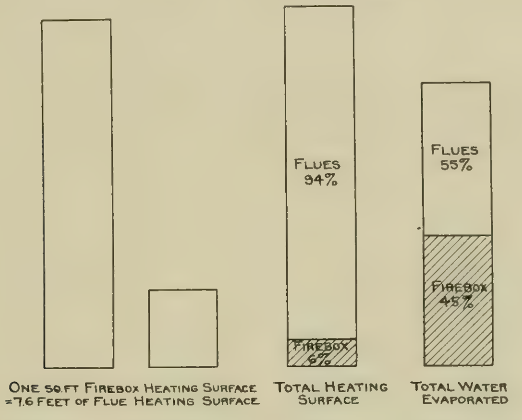
AMERICAN ENGINES

Railroad	Type	Boiler Pressue	Cylinder Dimensions	Total Weight	Firebox Heating Surface	Total Heating Surface	Number of Flues	Percentage of Firebox to Total Heating Surface	Class of Fuel
N. Y. C.	4-4-2	200	21 x26	176,000	180	3505	396	5.1	Bitum's Coal
Penna.	4-4-2	205	20½x26	176,000	166	2640	315	6.2	Bitum's Coal
C. R. R. of N. J.	4-4-2	210	20½x26	191,000	174	2967	325	5.86	Fine Anth.
U. P.	4-6-2	200	22 x26	202,000	175	3462	301	5.	Bitum's Coal
C. B. & Q.	2-8-0	210	22 x28	208,900	195	3827	462	5.	Bitum's Coal
C. & A.	4-6-2	220	22 x28	219,000	202	4078	328	4.95	Bitum's Coal
C. R. R. of N. J.	2-6-2	200	18 x26	165,000	137	1832	249	7.47	Anthracite
B. W. & G.	2-8-2	200	14 x24x26	166,900	174	2496	270	6.97	Lignite
A. T. & S. F.	2-8-0	210	17 x28x32	214,600	165	4266	652 (1¾" Dia.)	3.86	Oil

FOREIGN ENGINES

Railroad	Type	Boiler Pressure	Cylinder Dimensions	Total Weight	Firebox Heating Surface	Total Heating Surface	Number of Flues	Percentage of Firebox to Total Heating Surface	Class of Fuel
Paris, Lyons & M.	4-4-0	213	13⅜x21¼x25$\frac{7}{16}$	99,400	129	1934	150	6.7	Bitum's Coal
Baden State Ry.	4-4-2	235	13$\frac{7}{16}$x22$\frac{7}{16}$x24⅜	163,700	148	2260	279	6.37	Bitum's Coal
Nor. Ry. of France	4-4-2	228	13⅜x22x25.2	142,100	167	2275	126	7.34	Bitum's Coal
Great Eastern	0-10-0	200	18½x24	134,400	131.7	3010	395	4.37	Bitum's Coal
London & S. W.	Drummond Water Tube				229	745	No data	30.8	Bitum's Coal
Prussian State	Schmidt Super-Heater System								

These varied ideas and opinions as expressed and recorded from the date of Dewrance and Wilson down to 1903 led Mr. G. H. Henderson to remark in his book on "Locomotive Operation" that came out in 1904.—"So the Boiler grew, not in a very rational manner at first, as the proportions were not well known, nor are they now, and it was largely a guess as to how much



Graphic comparison of heating surface and evaporative capacities, wide firebox locomotives.

heating surface and grate area were necessary to maintain a definite tractive force at a given speed." He also adds in speaking of heating surface—"While as we have stated this is one of the principal problems of locomotive design, we are still considerably in the dark as to exact value."

The differences of opinion and the unsolved state of some of these problems have no doubt been factors to some extent in the activity which we have lately been witnessing in boiler development.

The Pennsylvania Railroad's series of tests conducted at St. Louis during the World's Fair in 1903-4 and afterwards at Altoona, did a great deal towards furnishing definite information on some of these problems. The work done by Prof. Breckenridge in connection with the Department of United States Bureau of Mines also added considerable to this particular stock of knowledge.

The tests conducted by Dr. Goss at Coatesville some two years ago among other things furnished some interesting data on the relative values of flue and firebox heating surface. These

tests showed that the average evaporative value of one square foot of firebox heating surface is 7.6 times that of one square foot of flue surface.

The latest and most comprehensive tests that have been conducted are those recently completed at Altoona by C. D. Young and referred to above. They substantiate in certain measures some of the earlier efforts of Petiet, Henry and others, and furnish valuable data for the present day designer. In these

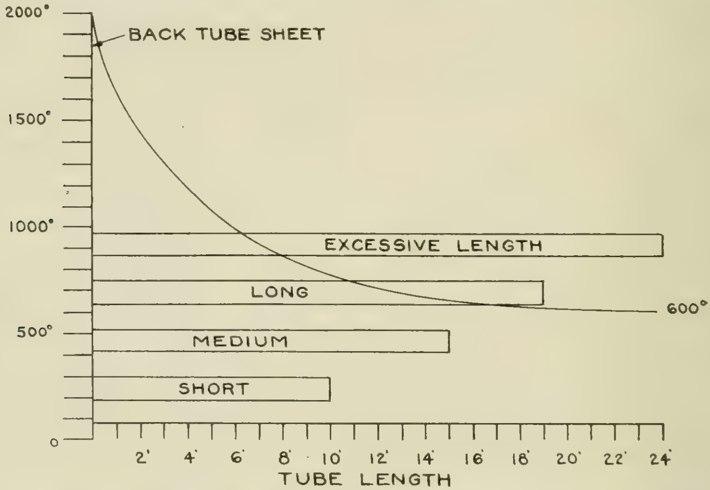


Diagram showing temperature range in locomotive boiler tubes.

tests the equivalent evaporation per square foot of heating surface was from 7.0 pounds to 16.8 pounds. This latter is not an exceptionally high rate, but the rate to which a locomotive can be forced is dependent upon the ratio of heating surface to grate area, and in this locomotive the heating surface was comparatively small. Rates of evaporation of 20 pounds per square foot of heating surface, as have been obtained with boilers of other designs, were not possible with this locomotive.

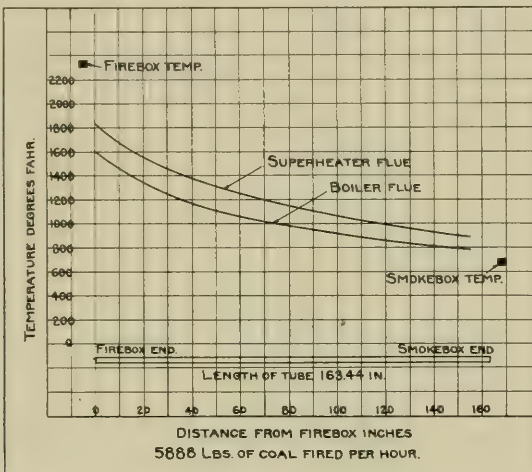
In connection with the matter of flue length, the following conclusions reached by Young are of interest.

(a) The most desirable length of tube depends upon how much the designer is willing to sacrifice in boiler efficiency to obtain rapid evaporation with some loss of heat.

(b) There is a rapid decrease of temperature in the tubes

for a distance of three or four feet from the firebox end, after which the temperature drop is more gradual until, with this short tube, the curve of tube temperature becomes flat toward the smokebox end, and therefore the heat transfer at the firevox end of this tube is much higher than at the smokebox end.

This is also in line with the conclusions arrived at by the Steam Engineering Division of the United States Geological



Curve showing temperature in superheater and boiler tubes. Penna. R. R. tests of Class E-6 locomotive.

Survey on account of which appeared in the Western Society of Engineers for September 1907.

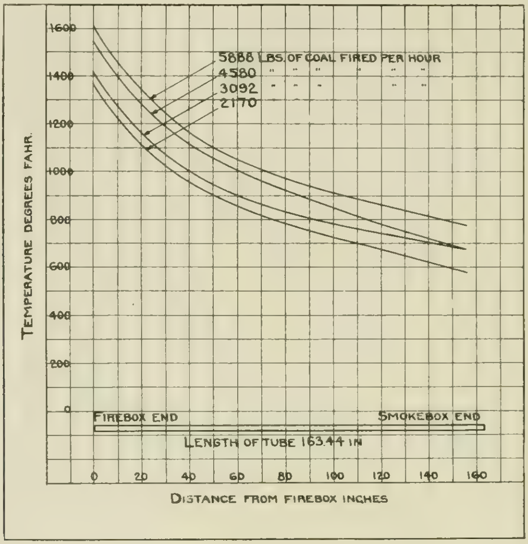
First. "After the velocity of the gas parrallel to the heating surface has reached a certain value, varying with the size of tubes, and the degree of temperature, the rate of heat absorption is almost proportional to the velocity."

Second. "Increasing the diameter of the flues decreases the efficiency of their absorbant power, and increasing the length of the flues beyond a certain limit, depending on their size, increases their efficiency very little."

Third. "Most of the resistence to the passage of the gas through the flues is at the entrance of the tubes. Lengthening of the flues increases the resistance very little."

Some of the facts established by Petiet and later by Henry and more recently confirmed by Young would see mto indicate

that there is a happy medium for flue lengths above or below which it would not seem advisable to go. This appears to be



Curve showing temperature in boiler tubes at different rates of firing. Penna. R. R. tests of Class E-6 locomotive.

in the neighborhood of 16 feet for 2 inches flues and about 18 feet or a little over for 2¼ inches flues.

The success of the present type of Mikado engines would also lead one to believe that the original ratio of firebox surface to total which obtained in some of the older type of engines was more nearly correct than the present ratio which runs in some cases as low as 3 per cent of the total. It might be worthy of note in this connection to call attention to the fact that the Atlantic type engine used in the Young tests had a firebox of 8:5 per cent of the total.

That the efficiency of combustion is largely dependent on the relative volume of firebox, has been clearly demonstrated, and it may be interesting to consider certain facts that have been developed in regard to the relations between combustion rates and efficiency.

Mr. G. R. Henderson, in an article in the American Engineer and Railway Journal, in June 1906, discussed the results of the

St. Louis tests and pointed out, in connection with the following data, that the efficiency decreases as the rate of combustion per square foot of grate area increases.

Engine Number	Maximum Coal Rate—Lbs.	Efficiency	Minimum Coal Rate—Lbs.	Efficiency	Average Efficiency
629	121	45	34	79	60
2512	191	42	21	81	68
734	140	60	33	78	68
533	120	54	18	74	65
1499	86	51	22	78	63
585	56	44	20	78	63
3000	134	39	26	63	60
929	74	47	19	75	63

Additional tests were made on the Pennsylvania Railroad testing plant at Altoona in 1908, and the size of grate was

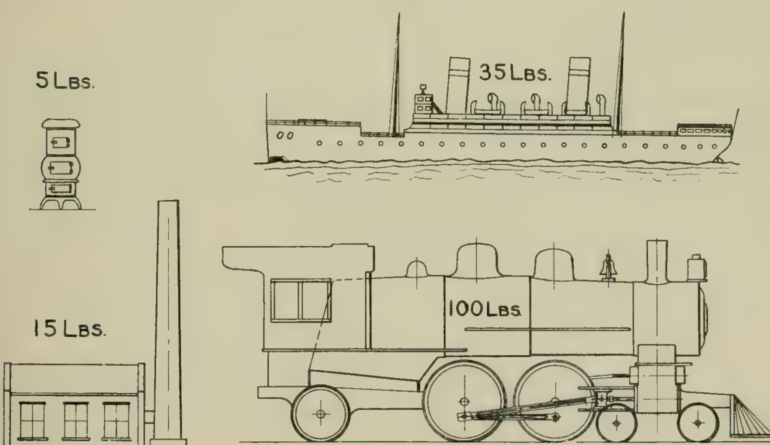
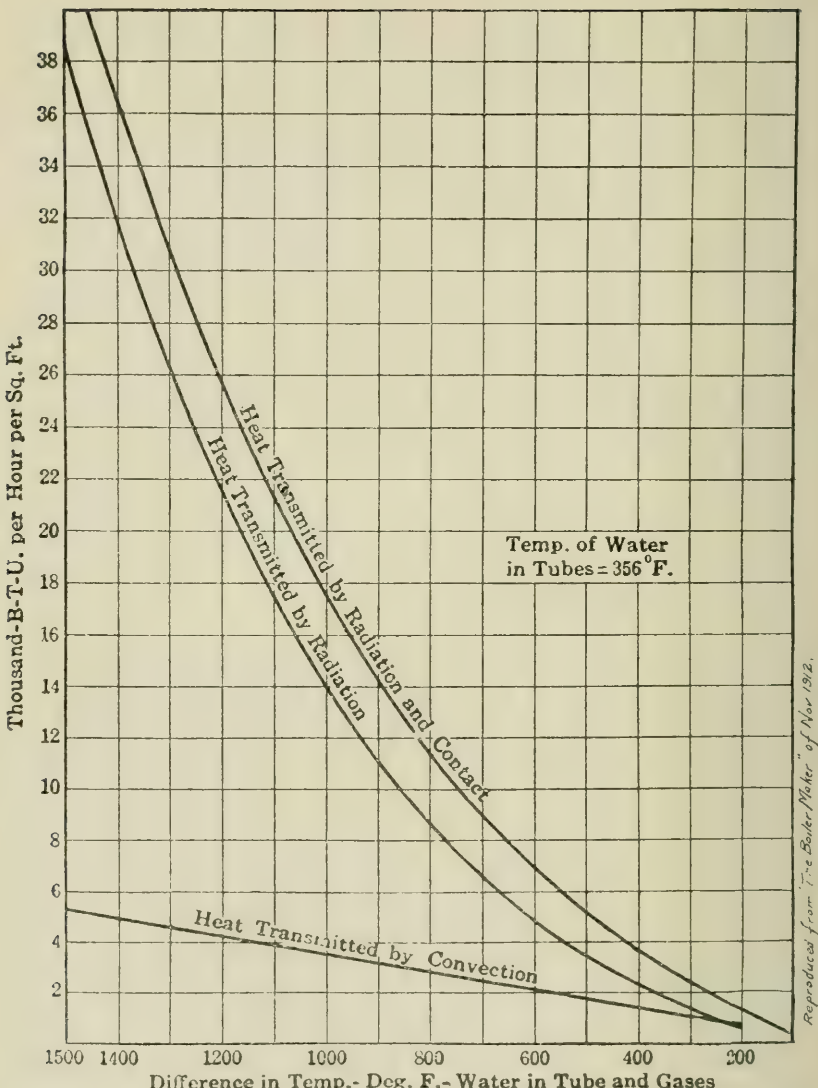


Chart in which sizes of objects represent comparative rates of combustion in pounds per sq. ft. of grate per hour.

changed in the same engine, with all the other elements remaining constant. In each of three separate tests, 4000 pounds of coal were fired per hour, but the grate area in the first case was 55½ square feet. In the other two, a part of the front grates was blanked, so that the grate area was first reduced to 39½ and then to 29.76 square feet. The combustion rates were, there-

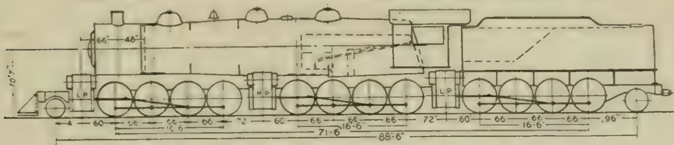


Curves showing the amounts of heat transmitted per hour by radiation, convection, and the sum of the two for various differences in temperature between water and hot gas or fire.

fore, respectively, 72,101 and 134 pounds per square feet of grate area per hour, and yet the boiler efficiency was practically unchanged; the reason being that in these three tests practically

the same opportunity for complete combustion was given

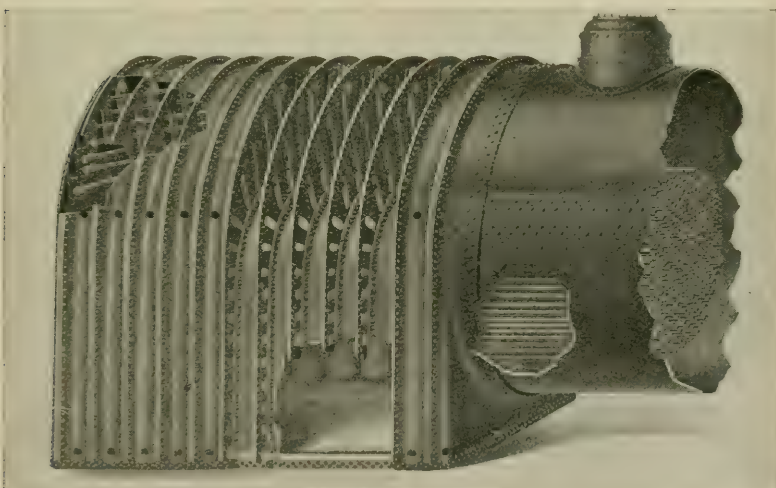
DIAGRAM OF LOCOMOTIVE HAVING GREATER TRACTIVE POWER THAN ANY ENGINE EVER BUILT



ERIE'S NEW SIX CYLINDER ARTICULATED MALLET COMPOUND LOCOMOTIVE "MATT H. SHAY"

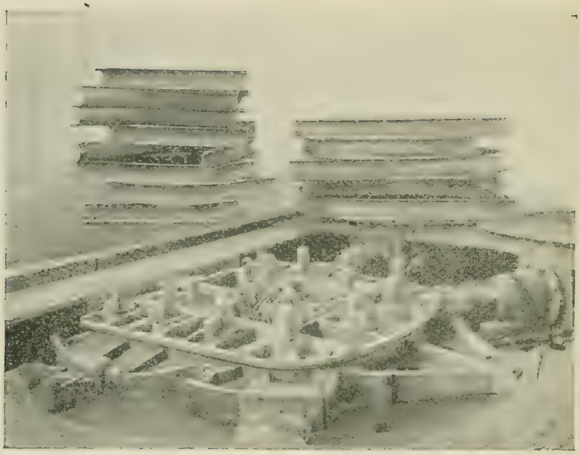
irrespective of the rate at which coal was fired per square foot of grate area.

Mr. L. H. Fry, in commenting on these tests, says: "It appears from these tests, that the efficiency of the absorption of heat is practically independent of the rate of combustion and evaporation."



Showing general details of secticnal firebox.

In the foregoing, I have endeavored to point out some of the more important factors which must be considered in the economical proportioning of a locomotive boiler. There have naturally been a great many developments in the perfection of details and in the application of special devices in connection with boiler designing many of which are important factors in the service given.

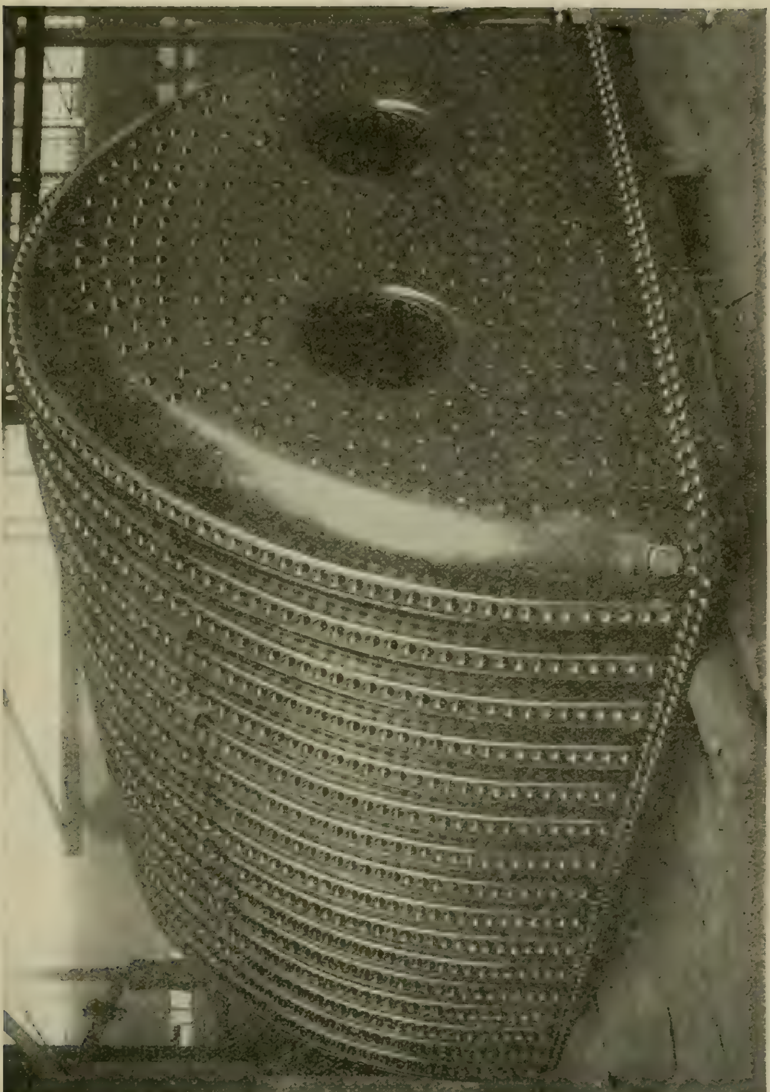


Horizontal hydraulic press for flanging channel sections for sectional firebox.

Among these may be mentioned the superheater, which while having been used to a great extent in Europe for a number of years has only within the past few years obtained due recognition in this country. Its use has resulted in an increase in boiler capacity not by reason of its influence upon the boiler itself, but because of its effectiveness in decreasing the cylinder demand for a given horse power output, and hence giving to the boiler a greater range of power.

The brick arch is another device which has resulted in not only increasing the capacity of the boiler, but also the efficiency, and its functions deal principally with the combustion problem. The arch gives better firebox conditions for the thorough mixing and burning of the gases, hence liberating more nearly the full latent heat contained therein. This not only saves coal, but by reason of the liberation of greater heat to just that extent increases the capacity.

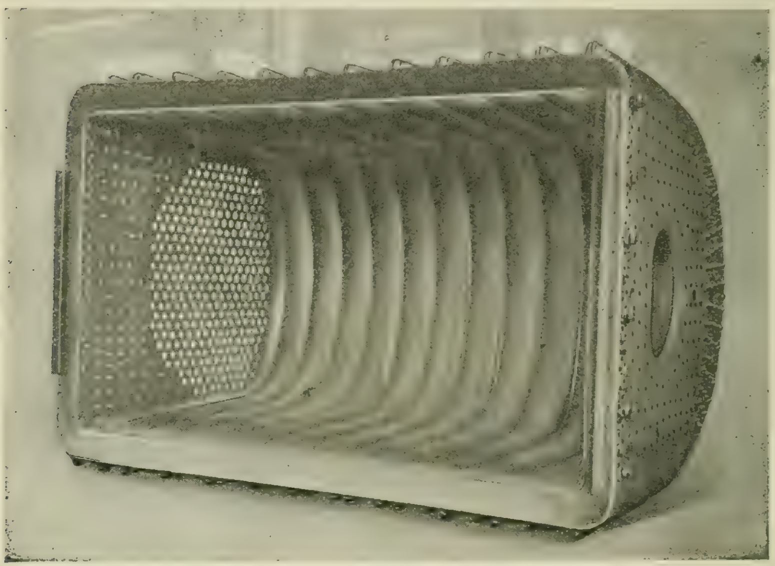
Along with the development of locomotive boiler proportions there has come also a corresponding development in the actual mechanical details of construction. Many of these are very closely related to the problems of capacity and economy. One of the most important and to which some attention should be given is that of sectional firebox construction.



Large sectional firebox for Philadelphia & Reading R. R.

As pointed out in the preceding paragraphs, it has been shown that the economical length of the tubes, especially for the heavy locomotives, such as are now used, appears to be somewhere in the neighborhood of of 16 feet for 2-inch tubes and

perhaps 18 feet for $2\frac{1}{4}$-inch tubes. In the design of a locomotive of long wheel base, such as a Mikado for instance or a

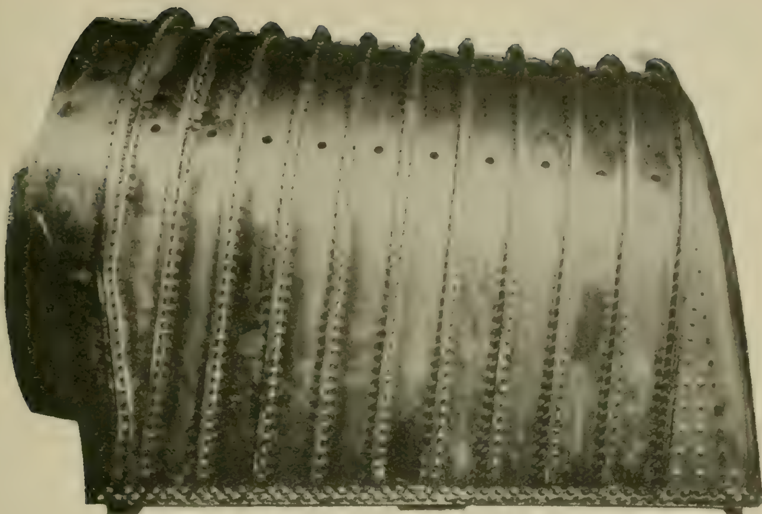


Interior of sectional firebox with butt-welded mud-ring joint.
Lehigh Valley Railroad.

Mallet, it is necessary that the entire wheel base, be covered with a boiler. If the correct proportions between firebox heating surface and flue length are to be maintained, it necessarily follows that serious problems are encountered in the design and maintenance of long flat sheets supported by stay bolts.

A simple calculation shows that the 400 flues in a modern Mikado locomotive will lengthen with a total force of over 9,000,000 pounds in expanding from a temperature of 32 degrees to 212 degrees and a locomotive crown sheet 17 feet long will have a total movement of about nine-tenths of an inch from a cold condition up to maximum working temperature. Such stresses as these are best taken care of by the sectional form of construction.

Every unit or section in this type is self supporting and complete within itself, and it, therefore, follows that the strength of the entire firebox structure is independent of the number of units of which it is composed. Due to its flexibility also the



Sectional firebox with sloping backhead for Pennsylvania R. R.

sectional form of construction takes care of the expansion strains in a manner that is not possible with long flat sheets of the staybolt type.

Then too there is another point to consider, if large engines are built according to the proportions proposed above with flues from 16 to 18 feet in length, the balance of the boiler being made up of firebox, it might be found in many cases that there would be an excess of grate area. This difficulty is overcome by the use of a brick arch of the Gaines design, which forms a bridge wall across the forward part of the firebox at the point where the grate should end, and provides at the same time a combustion chamber between the brick arch and the back flue sheet. The use of this device, therefore, enables one to design a large boiler with the proper length of flues and with the proper length of grate, and gives a firebox of large volume and heating surface with the added advantages of a combustion chamber.

I will now endeavor to show you by a set of slides some of the various successive steps in the development of the locomotive boiler starting with the original design worked out by Hero of Alexandria and ending with the latest and most highly

developed type of modern boiler, the Jacobs-Shupert sectional construction.

I also intend to show you in as graphic a form as possible the results obtained by the various tests I have mentioned. We will then have a moving picture reproduction of the low water test at Coatesville in which the strength of the sectional form of construction was conclusively proven and after that I'll be glad to try and answer any question you may ask in regard to any of the points I have brought up.

(A series of slide views with explanations by the speaker were here introduced and then the moving picture film of the low water test was given.)

PRESIDENT MITCHELL: The hour is getting late, but if any of you have any questions to ask or any remarks to offer, we will be glad to hear from you.

MR. D. J. REDDING: I might ask what experience you have had with that sectional type of firebox, where it has been in service for some length of time, as to the leakage of the seams. There was some doubt expressed when they first went into service as to whether it would stand expansion and contraction very long. I suppose they have several thousand rivets in those seams and while they are not exposed to the fire, the under side of each seam is exposed and more or less expansion and contraction takes place.

No doubt it is, as Mr. Whiteford says, one of the steps that make for advancement, and I think we will all agree that he is perfectly right that we want to get evaporating surface in the firebox rather than in the tubes. They are on the right track. Their construction there is getting greater surface in the firebox, provided they do not have too much trouble to maintain that type of firebox, and that type of joint. They certainly have a strong firebox. They have done away with staybolts, which have been a source of trouble for a great many years in firebox construction. If they can satisfy the people that they have a firebox that will last at least as long as the staybolted box and not give any more trouble from leaky seams than we now have, and eliminate staybolts, they will certainly have accomplished a great deal. And possibly they have gone farther than that.

MR. A. STUCKI: We certainly have had an interesting illustration of the great evolution in boiler construction from its

beginning to the present day, but in regard to the sectional boilers I would like to ask for some additional information. In the 90's the Lentz boiler was used quite a little on the Saxion State Railways. Its firebox consisted of corrugated sheets. Later on the Vanderbilt boiler appeared in this country. It was also based on the use of corrugated steel. Now the Shupert boiler follows in that same path with apparently excellent results. Inasmuch as the underlying principle in these cases are the same, namely, unlimited length and better transmission of heat to the water, the relative improvements must exist in the mechanical construction and therefore would like to hear about the various experiences and improvements in that direction.

MR. WHITEFORD: Mr. Redding asked whether it is possible to keep the crown seams tight. In answer to this, I would call attention to the low water tests at Coatesville, and I have shown you views of the interior of the firebox after this test. The conditions of this low water test were far more severe than any which would arise in ordinary service. Notwithstanding the high degree of heat to which the material of the sections was subjected, it was found after the tests that every seam between the sections was tight.

We do not have any record of the seams between the sections ever giving trouble by leakage under service conditions, and even if this did occur, it is exceedingly easy to calk this seam along the edge of the brace plate between the sections. Such calking would be along the edge of a plate, which is the ideal calking edge and not nearly so difficult nor unsatisfactory as the calking of a flat lap riveted seam. In calking a lap seam the force of the blow tends to open the seam and forces the plates apart whereas the calking of a seam between the sections of a sectional firebox does not have this tendency.

There are three fireboxes of the sectional type on the Lehigh Valley which have been in service about eighteen months and have each made a mileage of over 60,000 miles. I understand from the officials having these boxes in charge which are on a district having the poorest water supply on that road that they have never yet been touched by a hammer on the seams.

Mr. Stucki's question regarding the Lentz boiler is not quite clear to me.

MR. STUCKI: It consists of sections just like the Shupert but they are very much longer and corrugated and the crown sheet is much after the style of a radial boiler as to shape. As to heating surface and heat conduction to the water, it must have been satisfactory or else the Vanderbilt people would not have taken it up as they did.

MR. WHITEFORD: In answer to Mr. Stucki's question regarding the Lentz boiler, I beg to state that it is my best recollection that the type of firebox to which he refers is one used on relatively small boilers. The crown I believe is made from a flat sheet into which have been pressed transversely deep corrugations making of the crown practically a beam construction by transferring the load to the side sheets. Obviously this form of construction would from mechanical considerations only be limited to relatively narrow fireboxes. I do not believe this type of construction need be seriously considered for modern locomotive boilers.

The Vanderbilt furnace to which Mr. Stucki refers is an entirely different construction. Its only features of similiarity to the Lentz firebox or to the sectional firebox are the corrugations and these are radically different from the idea of the sectional construction. The Vanderbilt furnace is a modification of a type of construction used for a long time in marine boilers where the nest of flues is above the furnace and where the chance of low water is eliminated. The Vanderbilt furnace is of cylindrical corrugated form built into what is virtually a cylindrical extension of the boiler shell, and is hence surrounded on all sides by water. This furnace is a true circle in transverse section, and depends for its strength upon the circular form, reinforced by corrugations. The material from which the furnace is made must, therefore, be relatively thick to support the pressure. The Vanderbilt furnace is really more dangerous under low water conditions than an ordinary staybolt firebox for as soon as the top of the cylinder is dry the metal at that point becomes over heated and the strength of the entire structure is immediately impaired, resulting either in it bagging down or in its collapse. This same danger would be present in the Lentz construction under low water conditions. With the Vanderbilt construction the grate area is also necessarily limited, and I believe the Vanderbilt boilers were principally used in

connection with oil fuel. In the Vanderbilt construction there is also the difficulty of getting good circulation around the bottom of the furnace, which tends to give unequal expansion to the material and also impairs the steaming capacity.

I am quite familiar with the Vanderbilt furnace, as we had quite a number of them on the Union Pacific when I was connected with that railroad.

As to the heating surface, there is no advantage claimed for the additional surface due to the corrugations or to the sections. Tests which we have made seem to indicate that it is the projected area of the surface which counts and not the actual surface measured from the contour of the firebox sheets when curved. The reason for this is doubtless due to the fact that the radiated heat from the fire travels in straight lines, and so long as the fire is entirely enclosed on its top side with heating surface the radiated heat gets there whether the sheets are curved or flat and the sheets seem capable of absorbing whatever radiated heat gets to them. The principal point that I wish to bring out with reference to the sectional construction is that it affords the means for building fireboxes of large size without introducing elements of structural weakness.

MR. STUCKI: Just the same as in the Lentz and in the Vanderbilt boilers.

MR. WHITEFORD: I believe I have already explained the differences between the Vanderbilt, the Lentz and the sectional firebox. In the sectional construction each section with its corresponding brace sheet is a unit self supporting within itself, and hence not dependent upon the adjacent units insofar as strength is concerned. It, therefore, follows that if each unit is self supporting you can increase the number of units to any length of firebox desired without introducing any elements of weakness. This is not the case with the Lentz firebox nor with the Vanderbilt firebox for a failure of one part will necessarily pull down the remainder.

MR. F. H. BABCOCK: I would like to ask in regard to scale, in what condition do you find the fireboxes after the boiler has been in service a number of years as compared with the straight firebox?

MR. WHITEFORD: The accumulation of scale in this type of firebox does not seem to equal what it does in the

standard type of box. It seems as if the movement of the water and the breathing of the sections has a tendency to stop it. There are no dead pockets in which the scale can accumulate. Actual measurements after many months of service in some cases show little more than half of the accumulation of scale in the sectional type that there is in the flat sheet firebox under similar service conditions.

MR. A. J. HARNER: I would like to ask what time elapsed in the second test until the explosion occurred.

MR. WHITEFORD: I think about 22 minutes. It was 22 minutes from the time the test was started until the crown sheet failed and the water level was 14¾" below the crown sheet. It started at 225 pounds pressure and it had about 440 gallons of cold water injected after the crown sheet had been exposed. There was not as much cold water injected as in the sectional boiler. The attempt of the test was to run the conditions exactly parallel.

MR. E. M. LIVINGSTON: I would like to ask if any trouble has been experienced with this type firebox having the brace sheets fracture or break off where they connect with the outside sections. It occurred to me that this might be a source of trouble due to the expansion and contraction. I would like to ask also if any difference is noted between the sectional firebox and the ordinary type in the matter of time required to get up steam. We find that the boxes recently delivered to the Pennsylvania steam equally as well, if not better, than the staybolt boxes after steam is once gotten up, but it some times seems to me that in firing up they are a little slower than the staybolt fireboxes.

MR. WHITEFORD: As to the brace sheets fracturing as mentioned by Mr. Livingston I can only say that so far as we know this difficulty is not present. In some of the earlier designs of sectional fireboxes the straight flue sheet and door sheet were used and the rolling of the flues and the expansion of this flue sheet gave some trouble in the brace panels around it, which were in a straight line with the sheet. This difficulty has been overcome by using a dished flue sheet, which is independent of the braces, which support it and hence allows for expansion, the same as in any firebox.

As to getting up steam, it is to be expected that they fire up a little slower than the radial stay firebox because there is more water around the sectional firebox than there is around a radial stay firebox; but just as Mr. Livingston indicates, after steam is once gotten up this additional water is really an advantage.

PRESIDENT MITCHELL: Are there any further questions? If not, Mr. Whiteford, have you anything to add in conclusion?

MR. WHITEFORD: I believe I have talked long enough. I have nothing further to say except to again impress upon you the advisability of considering carefully all of the data which is available when designing a locomotive boiler. A consderation of all of this will, I am sure, make evident the desirability of keeping the flue lengths within the limits which have been indicated and in building a firebox of large size. The subject of boiler design is such a large one that it has been impossible for me in the brief space of this evening to point out more than a few of the most important elements which should control the design.

MR. REDDING: I wish Mr. Whiteford would insert in the proceedings a statement as to the actual amount of time which elapsed after the water left the crown sheet before the crown sheet went down in the staybolted firebox. In all cases of crown sheets which I have known of, the engineers always said they had two or three gauges of water. It might be interesting to know just how long the crown sheet was exposed, and how low the water became.

MR. WHITEFORD: In answer to this question: The test on the radial stay boiler started with the water 2½ inches above the crown sheet. In five minutes the water level had fallen to the crown sheet. About three minutes after the crown was bare and when water stood about two inches below the crown cold water was injected into the boiler and the water level raised about a half inch. When the water level was 7½ inches below the crown cold water was again injected and the water level held constant for about two minutes. Cold water was again injected for about the same length of time when the water level was 12½ inches below the crown. When cold water was

not being injected the water level fell at the rate of about one inch per minute. The boiler failed eighteen minutes after the water level was at the crown sheet. At the time of the failure the level stood 14½ inches below the crown sheet.

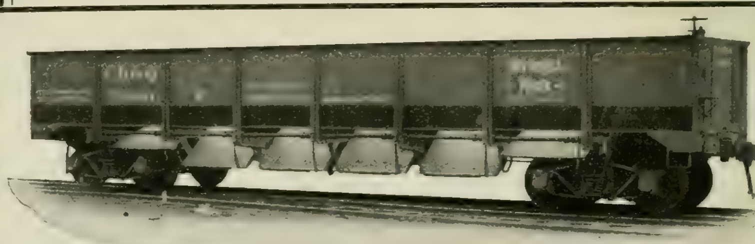
MR. STUCKI: We have listened with a great deal of profit and with much interest to this paper. It is no small matter to collect all this data, beginning with centuries before Christ was born, and to put it in such a condensed form. We appreciate it and I know I express the sentiment of all the members present when I move a vote of thanks to the speaker in recognition of his paper.

The motion was carried unanimously.

There being no further business.

ON MOTION, Adjourned at 10:25.

J. B. Anderson
Secretary.



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By Mr. W. R. Hulbert, New York, N. Y.

Westinghouse

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OF

The Railway Club of Pittsburgh

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING.

JANUARY 23rd, 1914.

The meeting was called to order at the Monongahela House by President Mitchell at 8 o'clock, P. M.

The following gentlemen registered:

MEMBERS.

Albree, C. B.
Amend, G. F.
Anderson, J. B.
Antes, E. L.
Babcock, F. H.
Balsley, W. T.
Barth, J. W.
Battenhouse, J.
Bauer, A. C.
Blackall, R. H.
Brown, J. Fred.
Brunner, F. J.
Burghean, A. L.
Butler, W. J.
Byron, A. W.
Cassiday, C. R.
Cassidy, D. E.
Cato, J. R.
Chapman, B. D.
Chester, C. J.
Clark, C. C.
Cline, W. A.
Code, J. G.
Coho, O. C.
Cooper, F. E.
Coulter, A. F.
Courtney, D. C.
Cunningham, R. I.
Curtis, Wm. R.
Dalton, C. R.
DeArment, J. H.
Deagen, J. J.
Detwiler, U. G.
Doty, W. H.
Emery, E.
Englert, A. F.
Felton, F. J.
Ferren, R. O.
Gale, C. H.
George, M. E.
Gillespie, W. J.
Greiff, J. C.
Grewe, H. F.
Grimshaw, F. G.
Gross, C. H.
Guay, Jno. W.
Gulich, H.
Hair, H. J.
Hardman, H. J.
Harriman, H. A.
Haynes, J. E.
Hays, M. D.
Henderson, J. W.
Herbick, N.
Herrold, A. E.
Hershey, J. E.
Hilty, H. A.
Hink, G. L.
Hoffman, C. T.
Howe, D. M.
Howe, H.
Hurley, Theo.
Huff, Geo. F. Jr.
James, Robt. E.
Jameson, A. A.
Johnson, A. B.
Jordan, J. E.
Kelly, H. B.
Kinch, L. E.
Knickerbocker, A. C.
Kinter, D. H.
Koch, Felix
Lanahan, Frank J.
Laughlin, E. J.
Laylan, M. A.
Lindner, W. C.
Livingston, B. F.
Lobez, P. L.

Low, J. R.
Mackert, A. A.
Mason, Stephen C.
Mensch, E. M.
Millar, R. J.
Mitchell, A. G.
McBurney, C. H.
McCann, J. P.
McCollum, G. C.
McFeatters, F. R.
McKinstry, C. H.
McNaight, A. H.
McNulty, F. M.
Newbury, E. H.
Newell, E. W.
Newman, L. L.
Obermier, H.
Painter, Jos.
Parke, F. H.
Partridge, F. G.
Phillips, Lee
Pie, Jos. J.
Porter, H. V.
Postlethwaite, C. E.
Pratt, I. D.
Pulliam, O. S.
Quest, W. C.
Rabold, W. E.
Redding, D. J.
Rhine, Geo. B.
Rhodes, R. W.
Richers, G. J.
Richardson, L.
Riley, T. J.
Robbins, F. S.
Ryan, Wm. F.
Sandman, A. G.
Sarver, G. E.
Schomberg, W. T.
Sigafoos, Gus.
Sleeman, Wm. C.
Smead, D. N.
Smith, J. B.
Smith, M. A.
Smoot, W. D.
Snyder, Jos.
Snyder, J. W.
Stark, F. H.
Stucki, A.
Suckfield, G. A.
Sullivan, W. H.
Summers, J. R.
Swope, B. M.
Thurlby, A. R.
Trappe, W. C.
Travis, J. H.
Trautman, H. H.
Trautman, J. Jr.
Towson, Thos. W.
Tucker, J. L.
Turner, L. H.
Ulmer, E. F.
Walker, J. W.
Watkins, Geo. H.
Walther, G. C.
Walter, W. A.
Ward, R. H.
Wardale, H. G.
Wardale, N. H.
Warne, J. C.
Wertz, Peter
White, F. L.
Wittig, Wm.
Wood, R. C.
Wood, V. V.
Wyke, J. W.

VISITORS.

Austin, F. S.
Bartan, J. H.
Benedict, W. N.
Benson, R. W.
Berg, A. E.
Bouger, G. M.
Daar, R.
Dette, R. E.
Evans, T. J.
Halloran, F. O.
Heird, Geo. W.
Howard, Geo.
Kelley, H. D.
Hulbert, W. R.
Kennelly, T. J.
Korn, J. N.

Leeper, Jas. A.	Seley, C. A.
Maier, J. L.	Simpson, I.
Mott, Saml. L.	Smith, A. C.
McGhee, W. S.	Smith, E. M.
McMunn, D. G.	Steinbrunn, J. J.
McVicker, G. R.	Strong, O. D.
Mackenzie, Jas. A.	VanNormann, A. R.
Perrott, E. W.	Walker, E. N.
Pollock, C.	Ward, John
Roemer, M.	Ward, John J.
Roemer, W.	Williams, L. H.
Ransbury, F. S.	Wilson, Jas.
Ritts, W. H.	Wilson, Thos. A.

PRESIDENT: The attendance cards being filled out, the roll call will be dispensed with.

The minutes of the last meeting being in the hands of the printer the reading of the minutes will be dispensed with, if there is no objection.

The Secretary read the following list of applicants for membership:

Austin, F. S., District Sales Manager, Davis-Bournonville Co., 2930 Penn Avenue, Pittsburgh, Pa. Recommended by Chas. S. Foller.

Bradley, W. C., Clerk, Union R. R., 632 Fourth Street, Braddock, Pa. Recommended by R. H. Ward.

Cooner, Lewis D., Supervisor Manual Training, Sharpsburg Public Schools, 2108 Perrysville Avenue, N. S., Pittsburgh, Pa. Recommended by F. L. White.

Duer, James J., President, Duer Spring & Manufacturing Co., P. O. Box 669, Pittsburgh, Pa. Recommended by Frank J. Lananhan.

Fulton, A. M., Assistant Superintendent Fort Pitt Malleable Iron Co., 714 Montour Street, Coraopolis. Recommended by Frank J. Lanahan.

Graham, Harry C., Treasurer, Graham Nut Co., 1608 State Avenue., Coraopolis, Pa. Recommended by Frank J. Lanahan.

Hauser, James W., Enginehouse Foreman, P. R. R., Liberty Street, California, Pa. Recommended by W. T. Montague.

Heird, George W., Yard Master, B. & O. R. R., 312 Winston Street, Pittsburgh, Pa. Recommended by Gus Sigafoos.

Holmes, John McC., Cashier, National Car Wheel Co., 107 Woodland Avenue, N. S., Pittsburgh, Pa. Recommended by D. C. Courtney.

Hood, W. S., Freight Claim Agent, W. P. Ter. R. R., Wabash Building, Pittsburgh, Pa. Recommended by C. O. Dambach.

Hopkins, H. V., Assistant Train Master, B. & L. E. R. R., Box 117, Butler, Pa. Recommended by B. F. Fluent.

Howard, Ronald, Machine Shop Foreman, U. R. R., Box 72, Turtle Creek, Pa. Recommended by J. W. Wyke.

Jones, Marvin, Assistant General Foreman, Pressed Steel Car Co., 215 Sprague Avenue, Bellevue. Recommended by R. W. Elverson.

Koll, Jacob F., Chief Clerk to Auditor, W. P. Ter. R. R., 523 Wabash Building, Pittsburgh, Pa. Recommended by F. J. Brunner.

Lanahan, J. S., Sales Rep. Fort Pitt Malleable Iron Co., Box 1054, Pittsburgh, Pa. Recommended by Frank J. Lanahan.

Manns, F. F., Disbursement Clerk, W. P. Ter. R. R., 523 Wabash Building, Pittsburgh, Pa. Recommended by C. R. Cassiday.

Mitchell, John, General Foreman, U. R. R. Ament Apts., Margaret Street, Munhall, Pa. Recommended by T. T. Copeland.

Moore, R. C., Treasurer, W. P. Ter. R. R., Wabash Building, Pittsburgh, Pa. Recommended by C. O. Dambach.

Mott, Samuel L., Foreman, Duquesne Steel Foundry Co., 1711 Ridge Avenue, Coraopolis, Pa. Recommended by F. H. Stark.

McBurney, Chas. H., Gang Leader, U. R. R., 810 Amity Street, Homestead, Pa. Recommended by Wm. F. Ryan.

Newlin, C. E., Acting Traveling Engineer, U. R. R., 620 Talbot Avenue, Braddock, Pa. Recommended by J. W. Wyke.

O'Hara, E. C., Extra Agent, P. R. R., Box 244, Charleroi, Pa. Recommended by E. F. Krahmer.

Oplinger, W. M., Salesman, Celfor Tool Co., Buchanan, Mich. Recommended by A. H. Ream.

Patterson, J. E., Locomotive Engineer, U. R. R., 7236 McClure Street, Swissvale, Pa. Recommended by C. H. Thompson.

Smock, W. W., Enginehouse Foreman, B. & O. R. R., 218 Winston Street, Glenwood, Pa. Recommended by Gus Sigafoos.

Weaver, F. R., Secretary-Treasurer, Davis Brake Beam Co., Johnstown, Pa. Recommended by Frank J. Lanahan.

Wilson, Thos. A., Foreman Car Inspectors, P. R. R., 2111 Sidney Street, Pittsburgh, Pa. Recommended by A. W. Byron.

Zerbe, L. E., Passenger & Freight Agent, P. R. R., Box 54, Elrama, Pa. Recommended by E. F. Krahmer.

PRESIDENT MITCHELL: As soon as these names have been favorably passed upon by the Executive Committee the gentlemen will become members.

The report of the Auditing Committee was read by the Secretary, as follows:

Pittsburgh, Pa., January 5, 1914.

Mr. L. H. Turner,

Chairman, Executive Committee.

Dear Sir:

Agreeable to your request, I have made a careful audit and examination of the accounts of your Secretary and Treasurer covering the fiscal year ending October 24th 1913, and beg to advise that all cash received has been duly accounted for and all disbursements appear to be regular and necessary charges against your organization.

I hereby certify that the receipts and disbursements as stated in the reports of your Secretary and Treasurer, covering the fiscal year as above stated are correct to the best of my knowledge and belief; and that the balance shown at the close of the

aforesaid year, viz, $2607.53, agrees with the balance in bank at that time.

Respectfully submitted,

W. T. RICHARDSON,

Accountant and Auditor.

MR. D. M. HOWE: Mr. President and fellow members: The City of Pittsburgh and vicinity is now in the midst of a campaign in the interest of the University of Pittsburgh. Fortifying myself with the knowledge that the exchequer of our Club is in pretty fair condition, as shown by the report just read, I move you that this Club appropriate the sum of one hundred dollars toward the endowment fund of the University of Pittsburgh, as an evidence of our interest in the movement.

The motion was seconded and carried unanimously.

PRESIDENT MITCHELL: Gentlemen, next in order is the paper of the evening, entitled "Thermit and its Latest Development in Railway Shop Practice, by W. R. Hulbert and H. D. Kelley, of the Goldschmidt Thermit Company. The paper will be presented by Mr. Hulbert.

THERMIT AND ITS LATEST DEVELOPMENT IN RAILWAY SHOP PRACTICE.

BY W. R. HULBERT OF NEW YORK.

MR. PRESIDENT AND GENTLEMEN:

It is a great pleasure to be here tonight to tell you something about the Thermit Process, and I fell honored that your members have turned out in such large numbers to hear my story and witness a few demonstrations of what the Thermit Process can do.

Before talking about Themit, however, I wish to say a few words about aluminum, as that is the basis of the Thermit Process. Aluminum, as probably most of you know, is the most widely distributed metallic element in the earth's curst, but the reason that it is a comparatively expensive metal as compared to iron and other of the more common metals is because wherever aluminum is found, it is always in combination with oxygen

in one form or another, and it is only within comparatively recent years that any commercial process has been perfected which will separate aluminum from oxygen and enable the metal to be produced at a cost to make it generally available.

Frederick Wohler, Professor of Chemistry at the University of Gottingen succeeded in obtaining very small quantities of metallic aluminum about the year 1827, but for eighteen years after that the metal in any considerable quantity was really unknown, and it remained for a French chemist, H. St. Claire Deville, to isolate aluminum into a state of almost perfect purity and determine its true properties. This was in 1854. At that time, however, only very small quantities were available. It remained for another French chemist, Heroult, and an American metallurgist, Mr. Hall, to really produce aluminum in large quantities at a reasonable price, and this was worked out simultaneously by Heroult in Europe and Hall in America, both using the electric furnace for reducing the aluminum ore. As a result of this practically all aluminum produced abroad is made under the Heroult patents and in America under the Hall patents.

The fact that aluminum is hard to separate from oxygen is taken advantage of in the Thermit reaction as the high affinity of aluminum for oxygen permits of a chemical reaction between the two when they are heated hot enough. Chemists for many years since aluminum was discovered have known of this reaction and experimented with it in the reduction of different oxides, mixing finely divided aluminum with a metallic oxide, placing the mass in a crucible and then heating it until the reaction took place. It was found that this resulted in a very violent reaction, practically an explosion, so that the reaction was of no commercial value. Dr. Hans Goldschmidt, a German chemist, and metallurgist, discovered that this reaction could be controlled if instead of heating the entire mass he simply heated the mass in the crucible at one spot. The reaction would then spread through the rest of the mixture and at the end of the reaction he would have aluminum oxide or slag floating on top in a molten state and the reduced metal at the bottom of the containing vessel. This discovery was the result of experiments by Dr. Goldschmidt who was attempting to produce for the famous firm of Krupps, the steelmakers in Germany, pure metals to use as alloys with steel, and the first experiments were made

with chromium oxide and finally divided aluminum. This reaction was entirely successful, as aluminum combined with the oxygen in the chromium oxide and pure chromium metal was reduced. He later experimented with other oxides, sulphides and chlorides and succeeded in producing pure manganese, ferro-chromium, molybdenum, ferro-titanium and many other metals and alloys.

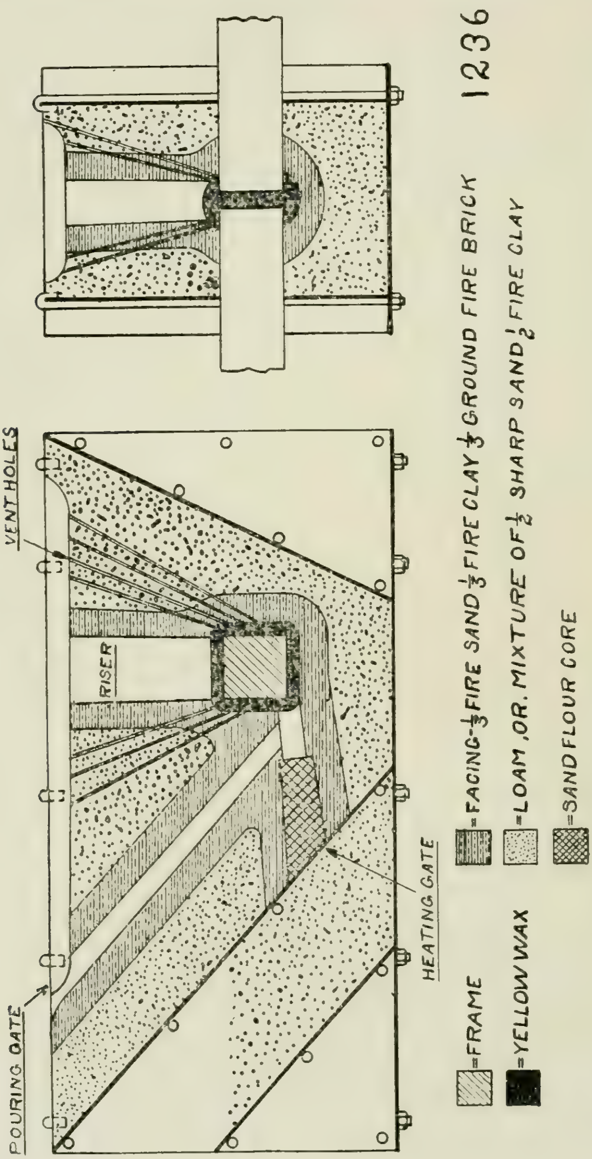
Among other oxides experimented with was iron oxide, but he found that this reaction not only produced a very pure, low carbon steel, but that the heat of this reaction was extremely high. No pyrometer will measure this temperature, but it has been worked out theoretically by Professor Richards of Lehigh University as approximately 4881 degrees Fahrenheit. Dr. Goldschmidt decided that this intense heat, produced so quickly and easily, could be used in many ways for welding purposes, and the Thermit welding process which is now so widely known throughout the world is the result.

In making a Thermit weld the parts to be united are first arranged with a space between them varying from one-half inch to two or three inches, depending upon the size of the sections. Where the pieces to be welded are in two parts it is a simple matter, of course, to provide the space but in the case of a fracture it is often necessary to cut out the metal in order to provide the space needed, and this is done by drilling a line of holes along the fracture and then cutting out the metal between the holes or else the space is cut out by means of the oxy acetylene cutting flame.

In the case of welding locomotive frames, which of course is the subject which you are most interested in, it is almost always necessary to cut out the fracture. It happens that one of your members has perfected a device for doing this, which I think you will be interested in knowing about. It consists simply of two hack saws spaced the required distance apart and operated by means of a compressed air motor. This will cut out the section very economically, but of course where speed is required the acetylene cutting flame is the most efficient.

After the sections have been cut out a wax pattern is formed around them of the exact shape of the reinforcement of thermit steel which is to be cast around them to make the weld. Thermit, as already explained is a mixture of aluminum

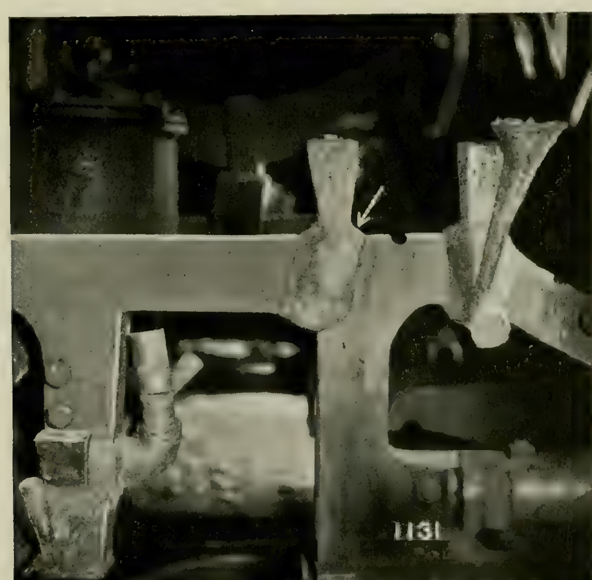
and iron oxide which, when ignited, reacts. The aluminum combines with the oxygen of the iron oxide while the iron is set free and comes down as a highly superheated liquid steel at a temperature of nearly 5000 degrees Fahrenheit, or about twice



Method to be employed in constructing molds for making Thermit welds and materials needed.

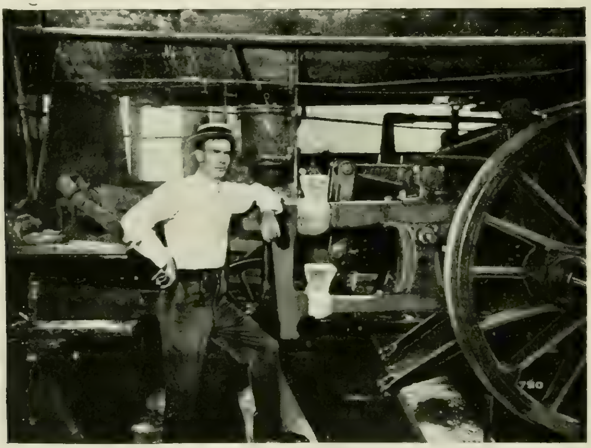
the temperature of ordinary molten steel. It will readily be seen that if we pour this steel around the sections to be united, it will melt those sections and amalgamate with them so that the whole will cool down to form a single homogeneous mass.

The wax pattern mentioned above is enclosed in a sand mold, wooden patterns being used for a pouring gate, a small preheating opening at the bottom and a large riser directly over the top of the weld. These wax patterns offer many advantages over wooden patterns which are sometimes used, as they do away with the necessity of making the mold in two parts. In order to remove the pattern it is only necessary to apply the flame of a compressed air gasolene preheater to the preheating opening and the wax is melted out, leaving the mold ready for pouring. For that part of the mold which comes in contact with the Thermit steel we use a mixture of one-third fire clay, one-third ground fire brick and one-third good sharp silica sand. This is mixed dry and then moistened just enough to tamp well. This is only used for the facing material and is backed up with a mixture of one-third fire clay and two-thirds sand. We recom-



Difficult frame welds on frame of Engine No. 154 of the Chicago, Rock Island and Pacific Railroad, Trenton, Mo.

mend this mixture, because it is highly refractory and the thermit steel goes into a mold at such a high temperature that a very refractory facing is necessary. The mold, of course, is thoroughly vented in accordance with good foundry practice. After the wax is melted out by the preheater the heating is continued until the parts to be welded have been brought to a good red workable heat. In the meantime the charge of Thermit is placed in a conical shaped crucible suspended over the pouring gate of the mold and when the sections are red hot the preheater is withdrawn, the opening plugged up and the Thermit charge in the crucible ignited. In from 40 to 50 seconds the Thermit reaction is completed and the Thermit steel tapped from the bottom of the crucible into the mold where it flows around and between the sections to be welded together, uniting them into one solid mass. The slag (aluminum oxide) does not enter the mold but overflows it so that it does not interfere with the welding operation.



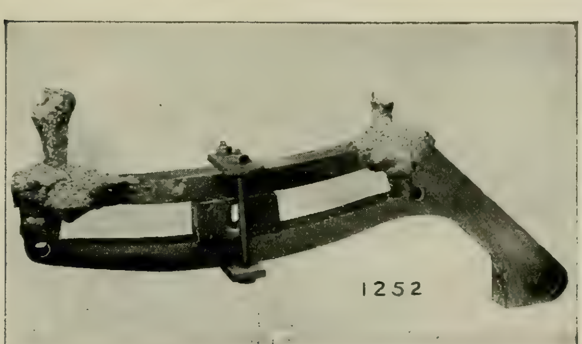
Two Thermit welds on Engine frame of the Toledo,, St. Louis & Western R. R. Co., Frankfort, Ind.

It will be seen that the process is a simple one and that the only outside power required to weld sections of any size is a small supply of compressed air for the operation of the preheater. The outfit is entirely portable and in many cases sections of very large size are welded without removal from their position, and therefore at a great saving in time and expense

over obtaining new parts or repairing by other means. This is particularly advantageous in the case of broken locomotive frames. It saves taking the frame out of the engine, welding it in a forge and replacing it. Furthermore the process permits of fusing a collar or reinforcement of steel all around the welded part, thus increasing the cross-section at that point and making it stronger than it was originally.

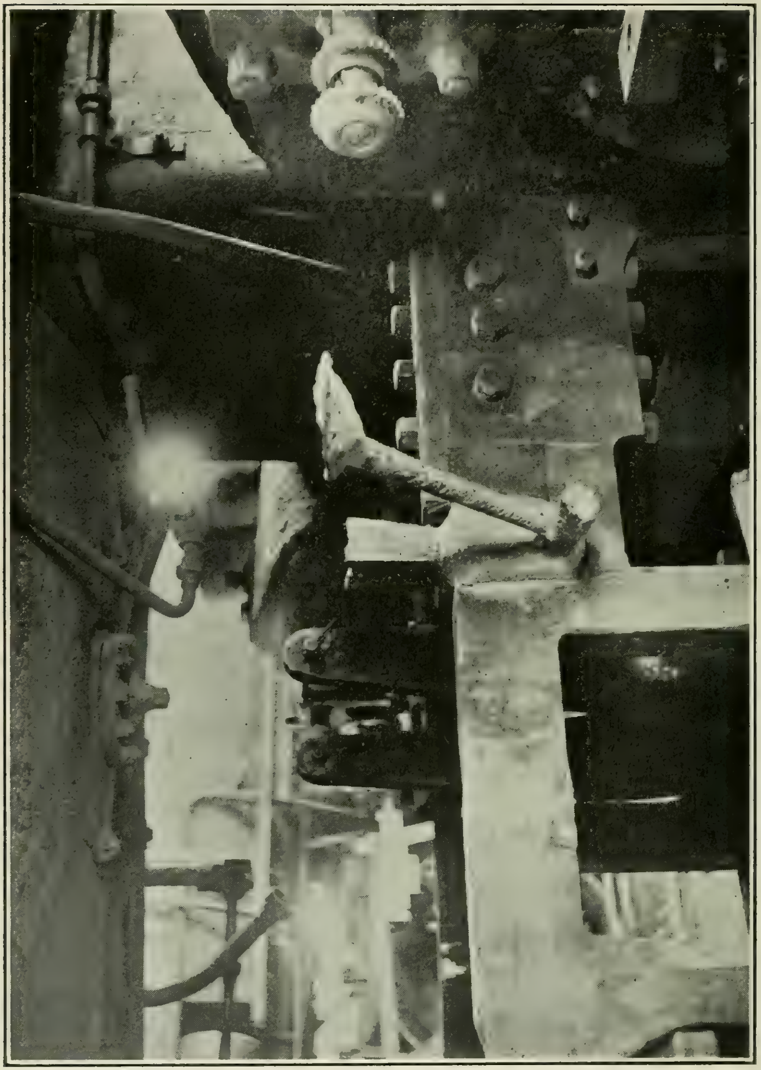
In welding a locomotive frame it is necessary to jack the frame apart about one-eighth to three-sixteenths of an inch before putting on the mold in order to allow for the contraction of the Thermit steel when the metal in the weld cools. Where one part of a double barred frame is being welded this contraction is allowed for by heating up the other section so as to expand it the required amount and holding that heat until the metal in

Broken engine link lined up previous to welding with Thermit.



Finished Thermit Welds on engine link before machining.

the weld has solidified, after which the heat can be taken off and both sections will cool down and contract together. For such work we recommend using a double burner preheater. One

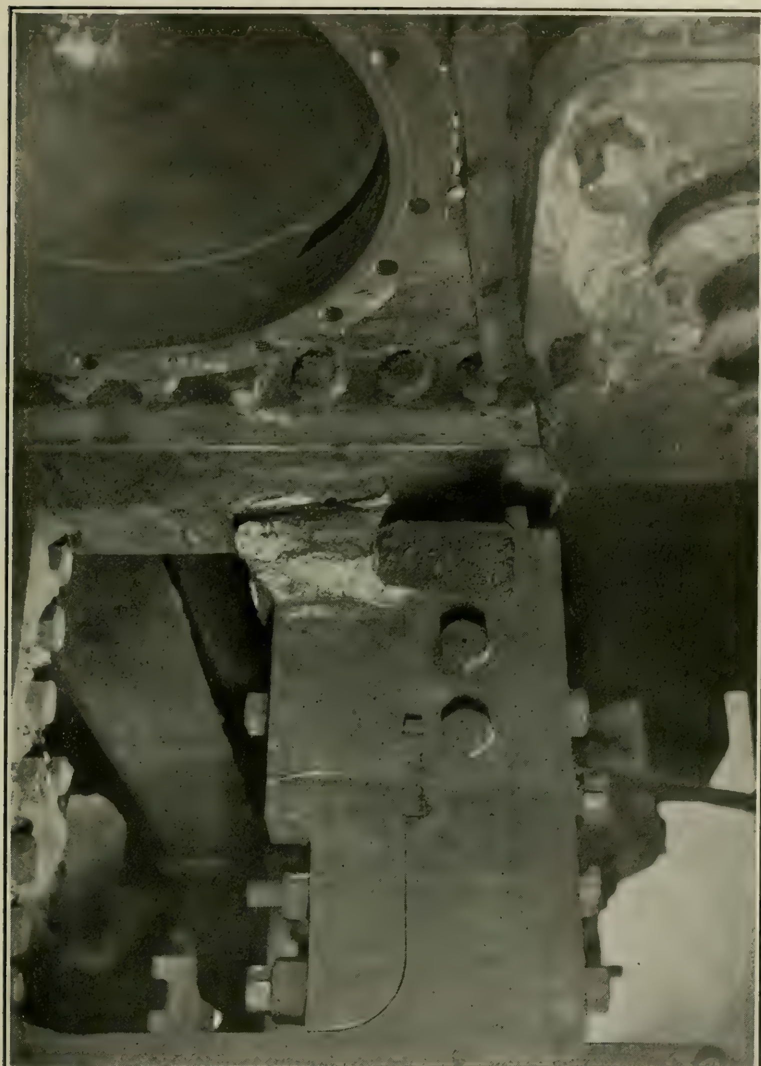


Splice of locomotive frame welded with Thermit.

burner can be used to preheat the sections to be welded while the other can be directed into a small brick furnace erected

around the second member in order to obtain the desired amount of expansion.

The great economy of the process in locomotive repair



Thermit weld in splice of locomotive frame, showing weld near cylinder.

work has led to its adoption by practically all the rail roads of consequence in the United States, Canada and Mexico and you

may be interested in knowing that the process is now used in 421 different railroad shops in North America.

Very little stripping of the engine is required for a Thermit weld, as it is only necessary to provide a clearance of about one foot all around the broken section. In fact it is usually only necessary to drop the driving wheels in order to effect a repair on a broken frame. Often the engine comes into the shop in the morning and twelve hours later the frame will be welded and the locomotive ready for service. The simplicity of a Thermit repair of this kind is clearly brought out in the moving pictures illustrating such a repair which are now being shown.

In the case of locomotive frames broken in splices it will usually be found that the break is through a bolt hole, that being a weak point in the splice. When we weld such a frame we not only cut out about one inch of metal along the break, but we also cut out a small amount of the adjoining frame so as to make it possible to cast a Thermit steel reinforcement entirely around the broken sections. This amalgamates with the other member of the splice, so that at the end of the operation both members will be welded together. We consider this by far the best practic as it gives a good strong job, and the only objection which is ever raised to it is the difficulty of separating the frames later on if it is desired to take them down again. This is not a serious objection, however, as it is only necessary to drill a line of small holes where the frames are welded together in order to separate them. When they are replaced a keyway can be cut and the frames bolted together in the usual way.

It is not only on locomotive frames that Thermit finds extensive use in railroad shops, as it can be applied to equal advantage in the welding of broken driving wheel spokes, side rods, connecting rods, rocker shafts, cross head guides, cylinder saddles, mud rings and other broken sections too numerous to mention.

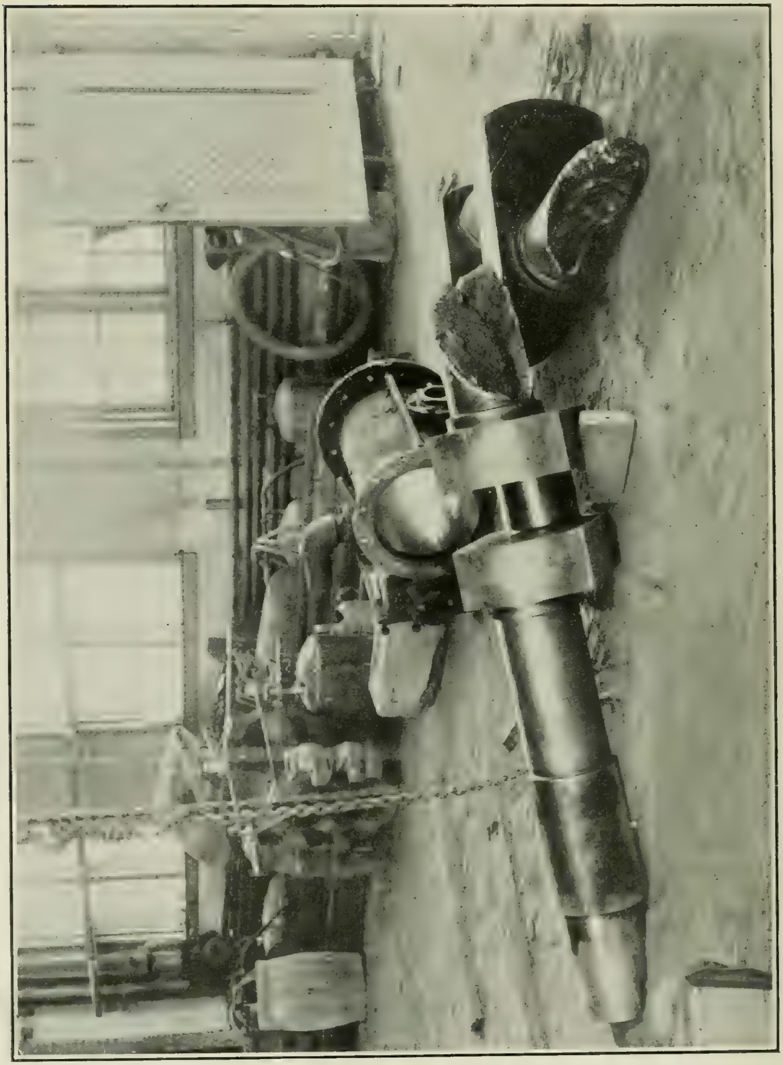
Aside from repairs in railroad shops the process is used extensively in the marine field for welding broken stern posts, stern frames, rudder frames and propeller struts of steamships. Here the process results in even greater economies than in the case of locomotive repairs owing to the fact that dry-dockage is exceedingly costly and every day saved means hundreds and even thousands of dollars. We make it a practice to execute

Guide yoke welded by Chesapeake & Ohio Railroad, Clifton Forge, Va., at a saving of $300.00.

such repairs by [illegible] keep the vessel in dry-dock more than forty-eight hours. The United States Navy has been one of the first to appreciate the advantages of the process and has used it very extensively at the Boston, New York, Norfolk, Portsmouth and Charleston navy yards. Furthermore the repair ships "PANTHER," "DIXIE" and "VESTAL" are completely equipped with Thermit welding outfits and have done very important work.

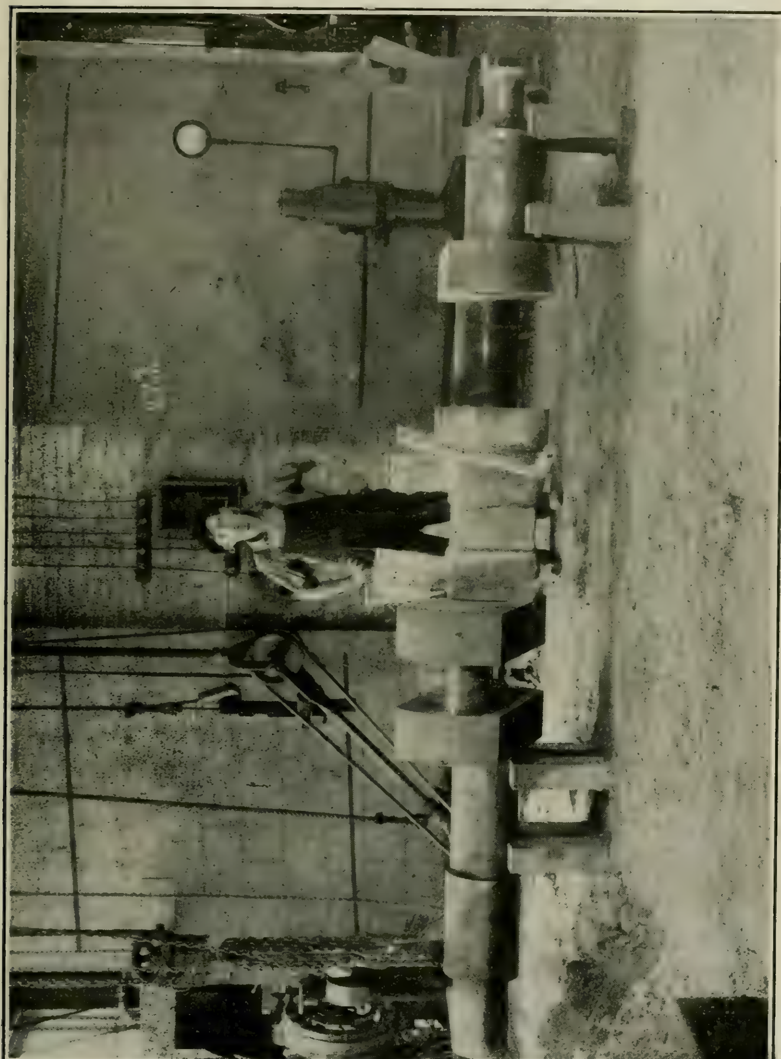
In the way of general repairs we have welded a great many crank shafts, particularly shafts for refrigerating machines. These shafts have to be aligned for quite accurately before making the weld, and we find it best to mount them on V-blocks supported on a machined bed plate as shown in the illustrations. The fracture is then cut out and the weld made in the usual

way. In some cases we find it necessary to cut out an entire bearing and weld in a block of steel to replace it with two Thermit welds, one at each end. The shaft can then be placed in a lathe and the bearing turned down to the proper size. It is usually impossible to keep these shafts in exact alignment during the welding operation, but they are seldom out more than one-thirty second of an inch. This is readily corrected by taking



9¼" crank shaft for refriger ating machine before welding.

a light cut off the bearings between the weld and one end of the shaft, considering the other part of the shaft to be true. While we have welded a great many of these shafts we have

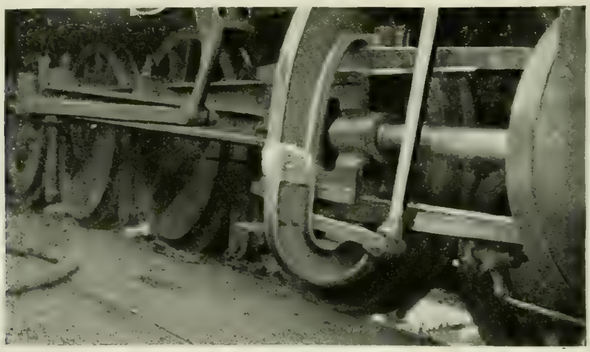


9¼" crank shaft with defective bear ing cut out and new bearing welded in. This is machined in a lathe and shaft is ready for service.

never had one break and our theory is that the shafts almost always break because of some flaw or defect in the material. This is often an old forging crack in the case of built up crank

shafts, which gradually spreads until finally the shaft gives way. Of course a shaft with such a flaw has no factor of safety at all, but if it were properly designed it should have a factor of safety of five. After the weld is made and all surplus metal machined off the shaft will still have a factor of safety of at least four, which is ample for all purposes and the owner will really have a better shaft than originally because the flaw has been located and eliminated and the rest of the shaft has been thoroughly tested.

Other repairs which I think would be of interest, and of which I take pleasure in showing you photographs on the screen, are large welds on gear wheels, fly wheels, hoisting engine shafts, rolls, pinions and rollmill housings. In the case of broken rolls

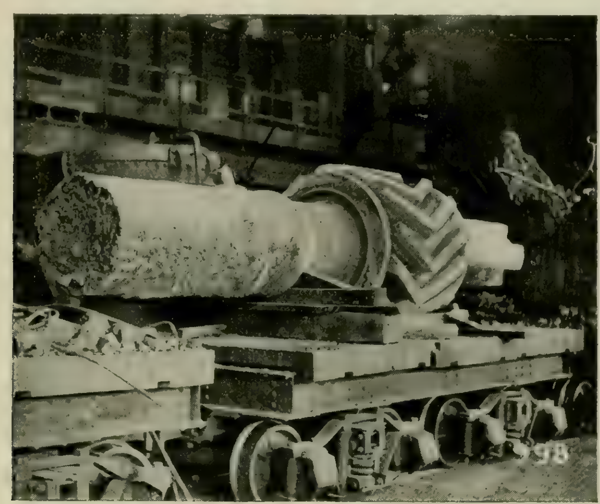


Guide yoke welded by Chesapeake & Ohio Ry., Clifton Forge, Va.

and pinions it is usually necessary to cast on entire new ends and as this would prove rather costly with Thermit steel, we have devised a method which is just as effective and considerably less expensive. This method is now generally used by practically all the large steel mills in the Pittsburgh District.

The broken roll or pinion is placed vertically in a pit and a mold constructed around the fractured end. This end is then heated to a red heat by means of gasolene preheaters, after which it is covered with Thermit steel to bring it up to a fusing temperature. Liquid steel from a ladle is then poured into the mold and about 6000 pounds allowed to run through and overflow. The overflow gate is then plugged up and the mold filled to the top. When the metal in the mold cools it will be found

to have welded perfectly to the steel of the roll. The metal passing through the overflow gate is not wasted, but is caught in ingot molds and used in the regular way.



Large pinion with new neck cast on by means of Thermit. The largest steel mills of the country use Thermit for these repairs.

Another important application of the Thermit is in pipe welding. The method of doing this work is novel and simple to say the least. Advantage is taken of the temperature of the slag and the fact that this slag will not stick to the pipe. On this account the mold for the purpose can be made of iron and surrounds the pipe ends which are accurately butted together and held in place with clamps. The Thermit is ignited in a flat bottom crucible and at the end of the reaction the slag which floats on top of the Thermit steel is poured into the mold—the steel going in afterwards. The slag and steel combined serve to bring the pipe ends up to a welding temperature, at which time they are squeezed together by means of the clamps and a butt-weld effected. At the end of the operation the entire mass may be knocked away from the pipe and the only resulting effect will be a slight upset at the joint.

This type of welded joint is used extensively in refrigerating plants, particularly where ammonia pipe lines are used and where a permanent non-leakable joint is desired. The Thermit

Two teeth welded in large steel pinion with Thermit, before trimming off gates and risers.

Process not only eliminates all joints from the pipe, but the welded joints are actually cheaper to install than ammonia flanged connections. For instance, the cost of welding a one-inch standard pipe by the Thermit Process, including labor, is about 65 cents while ammonia fittings will cost at least 75 cents. Another advantage is the speed with which the welds can be made, as two men can easily make from forty to fifty pipe welds per day. One man will face up the ends of the pipe with our special pipe-facing machine while the other follows and does the welding. As no outside power is required the welds can be made anywhere and the operation is just as economical in the field as in the shop.

I suppose the application of the Thermit process to street railway work will prove of considerable interest to you and I am therefore showing you some pictures of the Thermit welds on broken electric motor cases and truck frames. These repairs are executed at very slight cost in any shop and make it possible

to restore the broken equipment to service with the least possible expense and delay.

It is in rail welding, however, that the Thermit Process offers its greatest field of usefulness to street railway companies, as the apparatus is simple in the extreme and enables a few joints to be welded almost as cheaply as a large number.

Street railway companies are realizing more and more the importance of installing permanent joints in place of mechanical joints and welding is the only means to attain that end. The life of the rail depends very greatly on the efficiency of the joint as the rail always wear out and batter where the joints occur. Furthermore, the welding not only prolongs the life of the rail but also reduces the resistance of the return electric circuit, effecting a saving in power; but more important still, it tends to reduce damage by electrolysis to water pipes, etc., as the current stays in the rails when they are properly bonded instead of jumping to nearby water pipes.

In making a rail weld, we fuse Thermit steel around the base and flange of the rail and also around both sides of the head. We do not however weld the head entirely with Thermit steel, but place an insert of rail steel between the two rail ends and this is heated to a welding heat by the Thermit steel and slag and later when the weld begins to cool and contract it is compressed between the rail heads and butt-welds to them. In this way we get a weld of the entire rail section, but we do not in any way affect the wearing quality of the metal in the head of the rail which has to withstand traffic. After this joint has been welded it is ground to proper form by means of a special rail grinder which we have perfected for that purpose.

In addition to the various applications of the Process which I have described, I might state that Thermit is used quite extensively in foundries and steel work for reviving dull iron in the ladle and keeping risers of castings liquid. For that purpose we supply the Thermit in cans which can be attached to a long rod and plunged into the ladle of iron or held in the riser. The Thermit reacts and heats up the iron or steel in which it may be immersed.

I think that I have now covered the Process quite fully and will introduce my friend and associate, Mr. H. D. Kelley, who has had many years' experience in railroad shops before

taking up the Thermit Process. Mr. Kelley will be glad to answer any questions which you may wish to ask.

PRESIDENT MITCHELL: The paper is now open for general discussion.

MR. C. H. GALE: Is the wax that you use ordinary bees wax or what is its composition?

MR. H. D. KELLEY: We call it yellow wax. It is about all ordinary bees wax but to get around the pure food law we call it yellow wax. Ordinary bees wax answers very nicely.

MR. GALE: It is not a special preparation?

MR. KELLEY: No, sir.

MR. W. A. WALTER: Can cast iron be welded?

MR. KELLEY: Yes. You can not always take care of the shrinkage in cast iron. That fly wheel you saw was cast iron. If you can take care of the contraction you can weld it as well as steel. The only trouble is the cooling off. Cast iron when heated the first time will not shrink but grow. That is one trouble you encounter.

MR. A. STUCKI: I would like to ask a question, but before doing so will make a few remarks so as to explain what I am driving at.

That the Thermit is a very excellent means of making temporary repairs, there is no doubt. I know of many cases right here in the Pittsburgh district where engines with broken frames, etc., went back into service after three or four days, while by dismantling and making a regular weld, would have required at least three or four weeks.

Neither can it be questioned that in lots of cases castings can be fixed up by this process, resulting in a casting equally as good as if it had been right in the first place. This is true whenever the place fixed up is not subjected to maximum fibre stresses.

We have listened with interest to the remarks regarding the allowance for shrinkage. This, is of course, of the utmost importance to relieve internal stresses.

In the welded rail, however, this expansion and contraction will manifest itself in compressive and tensile stresses in the rail itself. This cannot be helped. Regarding Mr. Kelley's statement as to having a splice of the same material as the rail itself is undoubtedly true when the splice is inserted, but as rails are

rolled at a certain temperature in order to get the proper qualities, it is natural that the splice after being subejcted to such tremendous heat all around, will not retain the original strength and wearing qualities.

Now to come back to a joint, say in a locomotive frame, where all the strength of the original construction is required, I understood Mr. Hulbert to say that the joining material has about 90 per cent of the strength of a steel casting and he also said that the frame, after being united, has never broken at the joint, showing that the original casting near the joint must have been weakened in the material itself.

This is very natural too inasmuch as the casting cooling in the molds at the foundry has a coarse structure and is comparatively weak, while if properly annealed afterwards, changes to a fine and silky structure with much greater strength, and as soon as you heat parts of the frame to about 800 degrees (Centigrade) or over you reduce it to a coarse and weaker material.

Has your company ever made any investigation or tests, showing how and how far away from the joint or from the collar the original material was effected?

MR. KELLEY: I think Mr. Hulbert started out by saying that where the weld was machined off you could not expect to get beyond a 90 per cent joint. Where you leave a reinforcement you get a 120 per cent joint by actual tests.

The expansion in making a thermit weld is the same as any other weld. You make an allowance for expansion just as you would in a blacksmith shop weld or an oil weld. Where you can not allow for expansion sometimes you have to depend on elongation. I have just made five welds of that nature in one of the steel mills, where you have to depend on elongation entirely and the welds are holding up.

Thermit steel if it is properly mixed will run fairly well with cast steel, in tensile strength. It runs from 55,000 to 72,000 pounds in tensile strength.

As to the rail. As Mr. Hulbert said we have welded no rails except those that are covered. Where the sun and the cold can not get at them very much, the greatest strain you set up would be in the neighborhood of 20,000 pounds, whereas the rail will stand 55,000 to 60,000 pounds, so you have practically no trouble with breakage. As far as we can, we try to weld the rail when

the contraction is in, then you simply have a push. Does that answer your questions?

MR. STUCKI: Not as to the change in the cast steel.

MR. KELLEY: You know that in order to burn any steel you have to have it exposed to the atmosphere. Our steel is not exposed to the atmosphere in weld. You can heat it to almost any temperature.

MR. STUCKI: Do you not have similar conditions to what we have in the mould in casting the steel in the first place?

MR. KELLEY: Yes and no. But from actual experience it has shown that it does not affect the steel, as the steel is not at any time exposed to the atmosphere, consequenly it can not be burnt. It is practically impossible to burn it, if I may use that term.

MR. J. E. HAYNES: What is the total cost of making a weld on a locomotive frame?

MR. KELLEY: Approximately 25 cents a cubic inch. It depends entirely on the section. In my experience in making welds, and when I was railroading, the system I was with had made something over 4,000 welds cost for labor and material in the neighborhood of $35 per weld. On a railroad running into this city an engine came in one morning, and I made the weld. On Sunday morning I was in the hotel sleeping, the Master Mechanic sent for me to go down to the round house, by the time I got there the engine came in, about 7 o'clock, and at 6 o'clock that night the engine was going out on a passenger run. I have made a weld in 3½ hours from beginning to end. You could not expect an ordinary man to do that, but I had charge of the shop and we wanted the job we did it quick. Furthermore early last spring I was in the State of New York when in one of the large steel mills, in the vicinity of Pittsburgh, a 6,000 h. p. engine broke down. The connecting rod broke at crank pin brass, which broke the cylinder and everything else. I was asked to get on the fastest train and come to this mill. This company went to all the machine manufacturers around the country, as to getting a new rod, 90 days was the earliest they would agree to fit this engine with a new part. And a 6,000 h. p. engine is no small engine. I got there Tuesday morning at 4 o'clock and on Friday night at 7 o'clock they were rolling steel in this mill, a blooming mill engine.

MR. HAYNES: What is the cost of the outfit necessary to do that work.

MR. KELLEY: For ordinary work about $110.

MR. HAYNES: Could you make a weld in the lowest part of a locomotive cylinder?

MR. KELLEY: As I stated before, cast iron if not annealed will grow on first heat, thermit steel will shrink, and in cooling the weld it will crack. There are several roads in this district that have locomotive cylinders welded with thermit, that have been running three years. I would not recommend thermit for welding locomotive cylinders for about 50 per cent of the welds would be failures.

MR. D. J. REDDING: Has anybody succeeded in welding a crack in a flue sheet?

MR. KELLEY: Yes sir, but I would recommend oxy-acetylene or electric welding for that purpose. On one road that I know of a cracked flue sheet was welded with thermit, it ran one year until the flue sheet was taken out. I would not recommend thermit for that class of work. It is not economical. The oxy-acetylene or electric weld has it skinned a mile in that class of work.

MR. REDDING: I know it, but I wanted to know if that could be done.

MR. KELLEY: It has been done. This was a consolidated engine carrying 200 pounds of steam. This shop had neither oxy-acetylene or electric welding machines they had nothing else but thermit. Thermit is a quick and a cheap job, if used right, it is easy to handle.

MR. W. T. SCHOMBERG: I would like to ask in case of a link if case hardening is taken out what do you do in case hardening it again?

MR. KELLEY: The case hardening is taken out at weld. You can again harden it after welding.

MR. REDDING: You would have to do that in that link before you would return it to service.

MR. KELLEY: Yes, it should be again case hardened.

MR. REDDING: As a general proposition, I understand you have not tried to weld a frame which had been broken account of over-strain and had no special weakness at the point of breakage, it was simply too light for the work. That is, you

would not expect to successfully weld this and make it hold unless you had an opportunity of leaving a large collar at the point of welding.

MR. KELLEY: If that section was too weak you would expect it to break again. If you weld it with thermit you would not expect it to break in that particular place because you would reinforce. In case of weak section I would simply cut out that section insert new section and make two thermit welds. A case of that kind was shown on the screen. That was done in this state. The rocker box sat over that break and the tumbling shaft underneath. This frame was continually breaking at that point. This section was cut out and a new section made larger and welded in with two thermit welds.

MR. REDDING: What would you do if you were going to weld steel and wrought iron together?

MR. KELLEY: We do that right along.

MR. REDDING: What mixture do you use?

MR. KELLEY: Use the same mixture as for ordinary welding on frames.

MR. HARRY HOWE: In welding steel castings such as the rudder frame shown, wouldn't it be necessary to anneal the casting after it was welded?

MR. KELLEY: It is better to anneal any casting, but in this case it is not necessary for this reason, that you fairly well anneal by leaving it in the mold until it cools off. It is encased in a large sand mold on all sides of the weld this anneals the job very well.

In the case of the rod for the steel mill the general manager was on the job 36 hours without leaving and the superintendent of machinery was there. When he saw that I heated it in the mold he said "I don't think I will anneal this as I intended." We took it out of the mold after about 28 hours, machined it up and it is running today.

MR. HOWE: Isn't it a fact that there will be a line of demarcation between the original casting and the welded portion?

MR. KELLEY: I would say yes and no. It depends largely on the structure of the steel. If the steel I am welding is very high carbon steel and I run in low carbon steel of course

you can see on machining; but if it is about the same steel you can not tell.

I know of another case of a 13" piston rod for a Snow gas engine for a steel mill in this section. I welded it and when it was turned up you could not tell where it was welded. Before welding I took an analysis of the rod and tried to get about the same carbon as the rod. When it was polished up you could not tell where it was welded.

MR. HOWE: What I referred to was more the point Mr. Stucki tried to make, that there was a line of demarcation in regard to stresses set up in the casting.

MR. KELLEY: I do not think there are any stresses set up. It cools off rather slowly and if you allow the proper expansion I do not think you have any, or very little stress set up. If you spread the parts you want to weld prior to welding I do not think you have very much stress.

MR. HOWE: Wouldn't it be good practice to thoroughly heat the casting and let it cool slowly all over?

MR. KELLEY: I agree with you, if you have time. But you have not always time. I know of certain railroads today that make welds and allow them to cool off and heat them up again, but that is not done universally.

MR. HOWE: Railroads are insisting generally on all their steel castings being annealed, and we know it greatly improves the wearing qualities, or strength of the steel.

MR. KELLEY: I agree with you that castings ought to be annealed, even gray iron, but it is not done in a great many cases.

MR. W. T. WITTIG: That picture showed a weld on a riveter.

MR. KELLEY: The entire top part was broken off, the part that holds the rivet, it was simply cast on again out of Thermit steel.

MR. HAYNES: Have you made any welds of side rods and main rods?

MR. KELLEY: Yes, sir I can name a dozen roads in the country that do that. I was connected with a railroad for a number of years in Chicago. We bought some consolidated engines and the winter of 1910 was a very severe winter. One day the Superintendent of Motive Power came into the office

and said, we have an engine out here with her rods all broken and bent. It was a new class and we had no spares in stock, we were hard up for power. This engine came into the round house about 6:30 and at 9 o'clock that night the rod was welded and the next morning when the whistle blew at 7 o'clock, that engine was going out with a train. I know of high speed passenger engines running through this country that have main rods welded with thermit. On a run between New York City and Philadelphia I saw an Atlantic type engine with the side rod welded with thermit.

MR. HAYNES: Would you consider it good practice to make a weld in a driving box in cast steel?

MR. KELLEY: I would not, for this reason. You generally carry a lot of those in stock, and while I have never gone into that, of course it could be done. I have welded lugs on driving boxes, but I never weld them in the crown. In fact I do not know that I have ever seen a cast steel box broken in the crown. There must be something wrong with the box. It is too weak, and if you have a section that is too weak of course you ought not to weld it.

MR. W. D. SMOOT: I would like to ask if you have made any welds in large steam pipe.

MR. KELLEY: Not that I know of. For locomotives?

MR. SMOOT: No, for power plants or something of that kind.

MR. KELLEY: No, sir as high as 4″ we have handled but beyond that we have not gone into it very much. I expect to weld an 1¼″ pipe here tonight.

MR. HULBERT: We have welded an 8″ pipe experimentally and it was all right. But the difficulty is to obtain a uniform heat all around the pipe. When you get into the larger sections the heat is not evenly distributed and you do not get a uniform weld all around. In the smaller sections it is a very simple matter.

MR. REDDING: To what extent are you welding pipes for actual service?

MR. HULBERT: We have welded mostly refrigerating pipes to carry ammonia under pressure. Several refrigerating plants, notably at Prince Rupert, B. C., have over 6,000 welded pipe joints. And a great many refrigerating plants in New York

City where they sell refrigeration through pipes laid in the streets just as they sell gas, they all have their buried pipes welded with thermit. With our new method of facing the ends of the pipe it is possible to make a pipe weld for less than the cost of installing the ammonia fittings. The fittings for a 1" standard pipe cost 75 cents with all discounts off, and a thermit weld may be made on one inch pipe for 65 cents. And two men, one working the pipe facing machine and the other following and doing the welding, can make from 40 to 50 pipe joints per day. The Manhattan State Hospital bought their own outfit and we made a few welds in the first place and now they do their own welding, and they have all their refrigerating lines welded in that way.

MR. W. H. RITTS: How is the pipe welding done?

MR. HULBERT: The pipe welding is done entirely different from the welds you have seen described. We face up the pipe ends and put them inside a cast iron mold and hold them together by means of clamps. The thermit is ignited in a flat bottom crucible and the liquid slag is poured over the top. The slag covers outside of the pipe and inside of the mold with a protective coating which prevents the steel from touching either the pipe of the mold, if it did, it would stick or burn through. The whole mass brings the pipe ends up to a welding heat and then we squeeze them together by means of the clamps and get a butt-weld. The outside of the pipe is hotter than the inside so the upset is all on the outside of the pipe and the internal diameter is not affected in any way.

MR. RITTS: Could you handle a weld on chilled rolls?

MR. KELLEY: No, sir; not very well. I have never tried it.

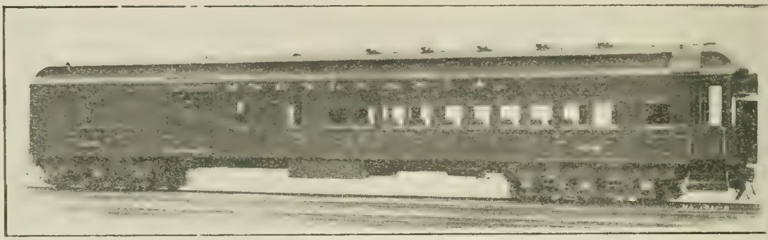
PRESIDENT MITCHELL: Are there any other questions? If not we will proceed at once to the demonstration.

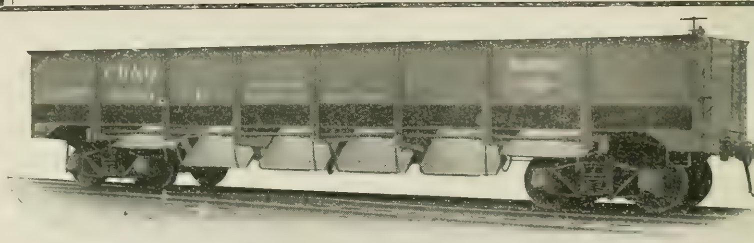
MR. F. H. STARK: It might be well at this time to extend a vote of thanks to these people for this very instructive lecture which they have given us and the demonstration that is to follow. It is a matter of vital interest to the railroads. I therefore move a rising vote of thanks to these gentlemen.

The motion prevailed by unanimous vote.

After the demonstration,

ON MOTION, Adjourned.





OFFICIAL PROCEEDINGS

RAILWAY CLUB OF PITTSBURGH

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Vol. XIII. FEBRUARY 27, 1914 No. 4.

EVOLUTION OF SCIENCE AND PERSONAL REMINISCENCES DURING THE LAST HALF CENTURY

By Dr. John A. Brashear.

INDEX—ADVERTISERS.

OFFICIAL PROCEEDINGS

OF

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING,
FEBRUARY 27, 1914.

The regular monthly meeting was called to order at the Monongahela House, Pittsburgh, Pa., at 8 o'clock P. M., by President, A. G. Mitchell.

The following gentlemen registered:

MEMBERS.

Allison, John
Amsbary, D. H.
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Deneky, W. F.
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Gearhart, J. A.
Gillespie, W. J.
Graham, H. C.
Grieff, J. C.
Gross, C. H.
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Guay, J. W.
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Hammond, H. S.
Harriman, H. A.
Hays, M. D.
Haynes, J. E.
Heird, Geo. W.
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Knox, Wm. J.
Koll, J. F.
Lanahan, Frank J.
Lanahan, J. S.
Lansbery, W. B.
Lanning, C. S.
Laughlin, E. J.
Lee, L. A.
Lehr, H. W.
Lewis, A. J.
Lincoln, L. P.
Lindner, W. C.
Lindstrom, Chas. A.
Lindstrom, T. J.
Livingston, B. F.
Lobez, P. L.
Longenecker, J. S.

Low, J. R.
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McClumpha, H. E.
McFarland, H. L.
McGough, J. E.
McIntyre, G. L.
McNaight, Arthur H.
McNulty, F. M.
Neff, John P.
Newbury, E. H.
Newell, E. W.
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Painter, Jos.
Parke, F. H.
Pie, Jos. J.
Porter, H. V.
Postlethwaite, C. E.
Pratt, I. D.
Pulliam, O. S.
Rabold, W. E.
Raser, Geo. B.
Redding, D. J.
Reymer, C. H.
Richardson, L.
Robbins, F. S.
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Smoot, W. D.
Snyder, F. I.
Stafford, Saml. G.
Stark, F. H.
Stewart, S. R. B.
Stucki, A.
Stumpf, F. L.
Suckfield, G. A.
Summers, J. M.
Summers, J. R.
Swayne, H. B.
Taylor, F. C.
Towson, T. W.
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Wardale, N. H.
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White, F. L.
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Woernly, H. F.
Wood, V. V.
Wood, R. C.
Woodings, E.
Yon, H. C.
Zortman, C. E.

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McGhee, Wm. S.	Steinert, E. G.
Rebstock, J. B.	Wohlert, H. A.
Reynolds, D. E.	Yungbluth, B. J.

PRESIDENT: We will dispense with the roll call as the attendance will be secured by the registry cards.

The reading of the minutes of the last meeting will also be dispensed with as the same is now in the hands of the Printer and will be mailed to you within a few days.

The Secretary read the following applications for membership:

Batchelar, E. C., Salesman, The Motch and Merryweather Machinery Co., Farmers Bank Building, Pittsburgh, Pa. Recommended by D. M. Howe.

Brady, T. J., Train Master, B & O. R. R., 142 Hazelwood Ave., Pittsburgh, Pa. Recommended by Gus Sigafoos.

Chamberlain, W. A., Auditor, Pressed Steel Car Co., 450 Dawson Ave., Bellevue, Pa. Recommended by Chas. A. Lindstrom.

Elliott, Jos. M., Auditor, Department of Supplies, City of Pittsburgh, 116 Glen Caldah St., Pittsburgh, Pa. Recommended by Gus Sigafoos.

Fogle, Emmett F., Chief Clerk, Chief Engineer, W. P. Ter. Ry. No. 1 Olympia St., Pittsburgh, Pa. Recommended by F. J. Brunner.

Hannington, Walter, General Bookkeeper W. P. Ter. Ry., 523 Wabash Building, Pittsburgh, Pa. Recommended by F. J. Brunner.

Lynch, W. F., Yard Master, B & O. R. R., 34 Ollysies St., Pittsburgh, Pa. Recommended by Gus Sigafoos.

Penn. Wm., Chief Clerk to Supt. M. P., Monon. Conn. R. R., 79 South 23rd Street, Pittsburgh, Pa. Recommended by F. M. McNulty.

Hitts, William H., Chief Engineer Power Station, Rolling Mills, Spang, Chalfant & Co., Pine Street, Etna, Pa. Recommended by J. E. Haynes.

Rodgers, G. W., Chief Clerk Car Accts. W. P. Ter. Ry. 523 Wabash Building, Pittsburgh, Pa. Recommended by F. J. Brunner.

Shanafelt, W. C., Conductor, B & O. R. R. 114 Cherry Street, New Castle, Pa. Recommended by Gus Sigafoos.

Wholey, V. A., Clerk, W. P. Ter. Ry., 523 Wabash Building, Pittsburgh, Pa. Recommended by F. J. Brunner.

Williamson, J. A., Drawing Instructor, P. & L. E. R. R., 1111 Charles St., McKees Rocks, Pa. Recommended by V. J. Burry.

Yungbluth, B. J., General Storekeeper, Pittsburgh Railways Co., 7237 Race St., Pittsburgh, Pa. Recommended by Frank J. Lanahan.

PRESIDENT: As soon as these names have been favorably acted upon by the Executive Committee, the gentlemen will become members.

SECRETARY: Mr. President and Gentlemen, we have the following resolution offered by the Entertainment Committee:

WHEREAS, the members of The Railway Club of Pittsburgh and their ladies were invited to and tendered a complimentary entertainment and dance at the Armory at Coraopolis, Pa., on Tuesday evening, January 27, 1914, by courtesy of the Fort Pitt Malleable Iron Co., the Duquesne Steel Foundry Co., the Pittsburgh Steel Foundry Co., and the Graham Nut Co., and

WHEREAS, a large number of the members of this Club with their ladies accepted the invitation and attended the event to their great enjoyment and passed a most delightful evening,

BE IT RESOLVED, that a vote of thanks be and hereby is tendered to Mr. Frank J. Lanahan, President, the Fort Pitt Malleable Iron Co., Mr. L. A. Way, Superintendent the Duquesne Steel Foundry Co., Mr. O. S. Pulliam, General Manager, the Pittsburgh Steel Foundry Co., and Mr. Harry C. Graham, Treasurer, the Graham Nut Co., for the courtesies and entertainment provided on this occasion, and that a copy of this resolution be forwarded to each of the parties referred to, and

be spread upon the minutes of this Club as a permanent record of the event.

Stephen C. Mason,
R. H. Blackall,
D. H. Amsbary,
Entertainment Committee.

This resolution was adopted by a unanimous vote.

The following communication has been received:

February 26, 1914, Pittsburgh, Pa.

Mr. J. B. Anderson,
Secretary, The Railway Club of Pittsburgh.

Dear Sir:—

On behalf of the Trustees of the University of Pittsburgh the Committee in charge of the recent campaign to raise the fund for the University desire to extend to you, all the officers and members of The Railway Club of Pittsburgh sincere thanks for your generous subscription.

Your subscription greatly helped to make the undertaking a success. As a result of it the Trustees more clearly see their way to take care of the great and growing needs of the University, as well as to raise in a less public way the fund to a much larger sum than shown by the result of the campaign, and thus assuring you and others interested in the welfare of the University, that it is bound to advance until it stands on a par with the best institutions of the kind.

Is is self evident that the greater and better the University become, the larger and more potent will be its influence in advancing the intellectual, industrial, commercial, civic and moral good of our city, making it a better place in which to work and to live.

With grateful acknowledgment and appreciation of your co-operation we are,

Very truly yours,
A. J Kelly, Jr.,
Chairman.

E. V. Babcock, A. J. Kelly, Jr.,
Howard Heinz, J. H. Lockhart,
A. R. Hamilton, Benj. Thaw,
Committee.

H. C. McEldowney, *Treasurer.*

Union Trust Co., 4th Avenue.

The Secretary announced the death of Joseph A. Shremp, Foreman Freight Car Builders, Penna. Co., Conway, Pa., which occurred on February 19, 1914. The President directed that a page be set aside to record the same.

PRESIDENT: If there is no further business we will proceed at once to the subject of the evening. The speaker is well-known personally to many of you and known by reputation to all of you by reason of his great achievements in the advancement of science and art. Notwithstanding the many and great honors that have been conferred upon him, he is the same good fellow that we have always known. It gives me great pleasure to introduce my dear friend, Dr. John A. Brashear.

DR. JOHN A. BRASHEAR: I am here to talk a little while about the evolution of science and my personal reminiscences covering a period of about half a century, and the first thing to which I would like to call your attention is photography. In 1882 I had the pleasure of talking with and to the good woman who sat for the first photograph of the human face. Many of you have seen and some have in your own families Daguerreotypes almost sacred relics to you. Now while Daguerre discovered the method of photography early in 1839, he was not the first man to make a photograph of an object not a human face. In 1802 Wallenstou discovered a method of making pictures, but they were evanescent, he could not retain the image any length of time. Daguerre exposed his plates two or three hours and made excellent pictures of such things as trees, etc. But Dr. John Draper, of New York having heard of the process of Daguerre, undertook to reduce the time of the sitting. Taking his own sister to the roof of the University he had her sit with her face covered with a whitepowder, with her head steadied with an iron clamp such as some of us here have been clamped with, and the first picture she told me she sat sixty minutes for. You can not keep a man or woman still that long today. He got a very fair picture, and Miss Draper told me you could even see the buttons on her dress.

This picture was taken a year before I was born, but the story was told me when she was an old lady, 84 years of age.

As mentioned I heard the story from her own lips and I have a copy of the first good picture which was taken in about 7 minutes. There is something else interesting to me about this picture. When I visited in London in 1892 I was the guest of the sons and daughters of Sir John Herschel. My wife and I were sitting at a table taking a pleasant "English tea" with four of the daughters and one of his sons, and in the drawer of that table was the original picture that I have just mentioned. They had searched for it all over the house but could not find it, and my friend Lord Kelvin was sent to the home at the request of Mrs. Henry Draper and searched the house, and opening the drawer of that table the original picture was found. A copy of this picture was presented to me by his grand-daughter.

It was not very long until the process was so improved that I can remember as a boy eight years old seeing my grandfather try to take a picture of an organ grinder and his monkey. He got the organ grinder, but the monkey they could not keep still long enough. The next development was in the various forms of the Ambrotype and later the tin type. How many of us have sat for tin types. Today all you have to do is to put in your dime and in about three minutes out comes the finished tin type. Photographs can now be taken so rapidly that in the little work shop on the hill we have made instruments for catching the flight of a cannon ball rushing through space at the rate of 1800 feet per second. Not only that, we can photograph it not only outside of the cannon but inside of the cannon. We can photograph it through a foot or more of its progress and then along side of it with a rotating plate we photograph the beat of a tuning fork and in that way we can tell exactly how fast it is going by counting the vibrations of the tuning fork and measuring the partial vibration. It can be measured to the one-one hundredth part of a second.

There is one interesting fact about photography, that is you can picture what the human eye can not see. This is particularly so with regard to astronomical photographs. The human eye when it looks in a telescope sees once for all, all it is going to see. The fact of the matter is that your eye becomes tired and you do not see as much after prolonged looking as you did at first. But the photograph is cumulative. It catches every tiny ray of light from the farthest star and makes an impres-

sion on the plate, until finally all those rays mingling on the plate build up an image. I have a picture where there is not a single star visible to the human eye, even through the best telescope in the world, not more than a thousand are seen, yet in the photograph no less than 200,000 suns like our own are shown.

Suppose you expose a plate to yonder green tree. How many vibrations of that green light do you suppose come from the tree and strike upon your photographic plate in a tenth of a second? I will give it to you in round numbers, because when you get into numbers like this a few more or less will not matter. About seven hundred million times seven hundred million vibrations in a second of time; or about seventy million times seventy million in a tenth of a second.

The great difficulty in talking about figures of such dimensions is to get an adequate conception of them. I gave a lecture once for the benefit of the unemployed and a friend of mine overheard a young man who had been there say "That man Brashear is one of the wisest men I ever heard talk or the d—dst liar." How did he know whether I was telling the truth or not? But these are facts. My friend the President of the Massachusetts Institute of Technology illustrates what I have just told you in this way. Suppose we were at the sea shore and there was a log being driven up by each wave that came in from the ocean. They come in at the rate of about one every six seconds. That log would have to be driven up against the shore two million, one hundred thousand years before it would strike as many times as the green wave of light strikes your photographic plate in a tenth of a second. Man is today able to measure the light wave, its velocity, its length, and the effect it has upon the photographic plate or the human eye, with just the same precision, and a great deal more, than you would measure the width of this table with one of the most perfect rules of the day.

The photograph is getting into every phase of human life. I have in my little den at home a photograph of every bone in the human body, built up by the man himself who took the photograph. It is one of the most wonderful pictures ever looked at. And the end is not yet. We can not tell what the photograph is going to do.

Come with me now into the domain of electrical science, with which I have been in a measure so long associated, though of course not in all its phases. I can remember very well when I was about six years of age that my grandfather made a very beautiful little engine driven by electricity gotten out of the acid action upon copper and zinc in the old fashioned Bunsen battery. When I was in England in 1888 I was the guest of my friend then Dr. Dewar, who has since been knighted. He one day took out of the holy of holies a little coil about one foot in diameter, covered over with a bit of muslin that had become worn and was quite ragged, but they did not like to change it at all because it was so precious. Laying it in my arms he said "Brashear, what do you think that is?" I said "Whatever it is, it is a mighty crude piece of apparatus." Don't say that about it," that is the father and the mother of all the dynamos and motors and electric light and electric energy of today. And that little coil made by Faraday was kept in the little room like a precious gem, because of its wonderful historic value. This is one of the things we Americans are lacking in. We let are historic inventions go by the board until it is too late to save them.

When my friend took out of the same sacred place, the little lamp made by Sir Humphrey Davy the safety lamp for fire which has been developed so wonderfully since, and put it in my hands, and then the chemical balance of Cavendish, I felt like a prince to have such a privilege.

Most of you have seen the marvelous development in electrical science. We have seen it in so many ways, particularly in the domain of that which is so valuable and so necessary in your own line of work. Let me tell you a little story which you will enjoy. I was a member of the American Association of Science in the department of astronomy and physics when we were invited to Terre Haute I think about 1889. We were given a luncheon at the Polytechnic Institute when there Mr. Thompson, who was Secretary of the Navy under Garfield, one of the guests, was asked to make a speech. He got up slowly and reluctantly and said "I do not know what I am going to say among a lot of scientific men like you, but I will tell you a story. In 1844 I was a member of Congress from this district. There were only two or three of us for the state at that time.

When we went to Washington we went part of the way on horse back, part of the way by stage coach, part by canal, and when we got up to Cumberland we took the little railroad. We usually planned to go to New York before we went to Washington. Well I was sitting in the hotel just after we got to New York when a gentleman from Massachusetts came to tell me, there was a gentleman across the street named Morse, who had an instrument he called an electric telegraph, who says he can send a message from Washington to Baltimore in less than two seconds, and he wants to get money from Congress to lay a wire so he can send messages. Well Thompson said "I was a farmer and didn't know anything about such things. But he plead with me and the next day we went over to see Morse and found him sitting at a table with a number of gentlemen standing around. He was exhibiting a machine with a little roll of paper tape coming out of it covered with dots and dashes. After we were introduced and the other gentlemen had gone away he told us he had ten miles of wire in the house through which he was sending his messages. After describing it, he said "Mr. Thompson, if you will ask me a question I will try to answer it on this machine." Henry Clay and James K. Polk were running for the presidency at the time, and do you know what I asked him? I asked him "Who will be the next President?" He put down the key and tapped and after a little the ribbon came out and he picked it up and it read "Henry Clay." Do you know what I told him? I told him I didn't know a d—d thing about his machine, but I liked its politics and I would vote for it."

"The conclusion of the matter was this. Congress voted him a $25,000 subsidy to lay the line between Baltimore and Washington. I voted for it; my colleague voted for it, and the act was passed. But at the next election for Congressman in my state I got through by the skin of my teeth and my colleague was defeated "for wasting the public money."

You may know the denoument, when Morse had laid his line only about half way he lost his signals. They did not know so much about induction in those days as we do now. I got the remainder of my story from Dr. Gardiner Hubbard, the father-in-law of Graham Bell. Morse went to Cornell and said "I can't get my signals and all my money is gone. I should

have put it up on poles." Mr. Cornell said "Go ahead, I will get the money for you." It was finished, and one of the first records that came through that wire was the announcement of the election of the President of the United States, but it was not Henry Clay. Then Ezra Cornell saw that the line was completed on to Philadelphia and New York, and you all know the subsequent story of the electric telegraph.

Only fifteen years ago I sat at the table with my friend, the greatest physicist I think that ever lived in the United States, Prof. Henry A. Rowland, of Johns Hopkins University, when there were four girls sitting at four type writers sending four messages over one wire in one way, and I was told there were four at the other end sending four messages the other way over the same wire.

And now look at what the wireless is doing. You know that up at the observatory we are trying to keep the time within four or five tenths of a second a year for the Pennsylvania Railroad. I am proud to say this is where standard time was first started by our friend Langley in 1879, when he had 4300 miles of railroad connected up with our time service. We give you the time with one of our best clocks within 4-10 of a second for the entire year. But now comes in the wireless. I took up the receiver at the National Observatory only a few weeks ago and listened to the ticking of a clock over 500 miles away, and now they are making efforts at Washington to hear the ticking of the clock in the Paris observatory. We have not yet signaled around the earth, but it will be done, and some of you may live to see it.

Kindred advance is shown in every form of electric energy. And what does electric energy mean? It is simply the stored up energy of the sun, stored up ages ago. We are taking the carbon that was stored in the coal fields and shoveling it into our boilers and transforming it into steam and putting that into the engine and bringing it back in the form of energy. And some day, though you and I may not live to see the day, we will utilize the energy of the sun direct. For do you know that there is one horse power per hour from the sun for every square meter—and that is a little over a square yard—of the surface of the earth where the sun is shining, all going to waste now. Some day we are going to utilize it. Not all of it is going to

waste now, because the sun lifts the water from the ocean deposits it on the land in rain that runs into the great Lakes, then over Niagara and turns the wheels in the power houses so that we do get some of it back second hand. So that electric energy from that small commencement away back in the days when Volta put the zinc and the copper plates together, has developed into these wonderful things of today.

I once told that story of the telegraph in the presence of Dr. Gardiner Hubbard, who was an inspiration to his son-in-law Alexander Graham Bell in the wonderful development of the telephone. He told me that the first person who listened to the telephone after its experimental stage, was Sir William Thompson, afterwards Lord Kelvin. He informed me he had stretched his wires through the Exposition Building in Philadelphia and wanted Kelvin to hear the message first. Kelvin was at one end ten or fifteen miles of wire away from Bell. When they were ready Kelvin put the receiver to his ear and Bell at the other end sent the message. Hubbard said Thompson dropped the receiver and said "My heavens, the thing talks." You know what has been developed in this wonderful instrument since that time until we can now do almost anything over the telephone except swear.

I do not wish to take too much time, but I would like to tell you something about the newer science, the science of aviation. Probably a little more than twenty years ago there was a man read a paper before an association of science at Cleveland on Soaring Birds. He had hidden himself among the bushes down in Florida watching the birds of prey, the eagles, vultures, etc., as they soared through air. He wanted to discover if they moved their wings at all in soaring. He could not find that they did so. Later the gentleman (a Mr. Lancaster) went to work on a lot of experiments, developing various forms of wings and throwing them through the air. In reading the paper he said he believed the time would come when flight would be possible in heavier than air machines. I was present at that meeting and I do not think I ever saw a man ridiculed by a lot of scientific men more than that poor fellow was. It was a shame, it was not fair. Professor Thurston, you Cornell fellows will know him, offered a prize if he would make a bird that would soar simply with a certain amount of energy

and keep itself suspended in the air with a certain amount of weight. The poor fellow went out of that meeting like a whipped dog and never came back to it again.

Langley was there and Langley heard the story of Lancaster. He commenced to investigate what the man said he had seen, because he was an observer. He had not guessed, he told them what he had seen in those soaring birds and what attempts he had made to imitate them. Langley went to work to see whether it were possible to develop a law of flight of a heavier than air machine. Maxim in England commenced the same kind of experiments, though on a different plan. I was with Langley all the time of his early experiments. That great man William Thaw—whose name is too much forgotten today, for he was the pioneer in nine-tenths of the scientific interest that was developed in the city of Pittsburgh thirty or forty years ago, and you railroad men especially ought to hold him in high honor for the part he took outside of his railroad accomplishment in the advancement of science in this old Smoky City—William Thaw saw the possibilities of a heavier than air machine and furnished the money for the experiments and up in the yard of the old Allegheny Observatory work was commenced. Bird after bird was tried. They were mounted on a great whirling table the outer end of which could whirl a mile a minute. Birds and various forms of planes were put on at various angles and the energy measured by delicate apparatus carried right into the observatory. Inside of two years Langley had deduced the law of flight. Maxim had done the same thing in another direction, and they only differed in their mathematical deductions by two per cent., showing how critically the law was studied out by the two men.

I remember very well when Langley put a condor, measuring about nine feet across its wings on the end of that great machine. A counter weight was put on the other end of the machine to counterpoise this great condor. The condor was mounted on a machine where the pressure of the air on the wings would lift it. It was set at various angles and rotated with the whirling table. I will never forget when that condor just commenced to raise itself. One of my men, whom Langley loved and asked to stay with him, told him before starting the whirling table he had better put on a heavier counterbalance

and fasten it tightly. The counterpoise flew off when going about 40 miles an hour, cut the smokestack of the boiler off and went through the building. My good friend Langley started on a run and only saved himself by doing so. But the birds were lifted and the problem was solved.

I am going to tell you something but few persons living know. When the Spanish War was threatening, McKinley was a peace man and did not want war to go on, earnestly hoping it might in some way be avoided. He came to Langley and said "Can't we get that flying machine of yours to going? If we could take a few bombs up and drop them into the enemy's camp it would stop the war." He said "I will get you $50,000 to do it." Langley got his $50,000 from Congress and went to work day and night. At the first flight, Alexander Graham Bell told me himself "I saw that first machine fly three quarters of a mile and come back to the place where it started." But there was no man in it then. The next machine when all ready was taken down the Potomac. Langley did not know how to launch the machine then as we do now. When the machine started off the top of the boat the little clip, like a horse shoe, that was to turn it up into the air with Mr. Manning, the machine broke and the aeroplane plunged into the river and was so badly injured that it was rendered useless and alas it also broke Langley's heart.

Langley had engaged a newspaper man for work in the Smithsonian Institution who was so much of a failure that he had to discharge him. That man lay in wait hoping for failure and when the machine plunged into the Potomac the word was sent out to the world by the Associated Press "Langley's flying machine has failed." Gentlemen, I spent the last half hour with my friend Langley in Washington before he started to his home where he took the fatal stroke that afterwards ended his life. His last words to me were "Brashear, my life work is a failure." I said no, Langley, if what you have done to add to the sum of human knowledge in your own beautiful science of astronomy was alone that which you could claim as yours, it is enough for one man's life work. But I could not cheer him and not long afterward he passed over to the "Summer Land."

When I was in California about eight weeks ago I had an interesting experience. I was driving out with a man who

wanted to show me the beautiful park he had given the city. Passing the houses of the Aero Club I said I would like to stop and see a flying machine. When I told one of the men in charge how long I had been associated with Langley in his flying machine work he said "Wouldn't you like to take a ride with me?" I had to decide quick. I said yes. It was driven by an eight cylinder engine and carried a thousand pounds of dead weight. I suppose he considered me dead weight. It would accommodate four people in two comfortable seats, just the same as a good automobile. I jumped in and I was perhaps four hundred feet above the ground before I knew the machine was off the ground. That flight to me was one of the most wonderful things I have ever experienced. The aeroplane sailed up and up and up. I thought I would have to keep as still as a mouse so I would not tilt it. But the operator informed me by signs I could move to either side for a view below. I tell you I felt a thousand times safer than I did when I came down in an automobile from Mt. Hamilton. When I moved from one side of the flying machine to the other it did not faze the equilibrium, and when the operator would occasionally take his hands off the steering wheel it went along just like a soaring bird.

I am telling you this story for just one purpose. The one wish I had when I was on that memorable flight was that Langley might have been sitting beside me, for he died without seeing the accomplishment of his hope after having worked on it almost half a lifetime, and how I did wish he was there for we were sailing so beautifully at 3100 feet above sea level.

Gentlemen I believe the time is coming when aviation in the air will be practically as safe as aviation on the ocean, when the equilibrator will keep the thing from turning over, and when spare engines which can be put in action at once, can be carried, for they can bring the machine down now without using power. It is only since 1807 the first steamboat sailed up the Hudson River. The first railroad in 1630 was a cart with wooden rails and a man in front of it. It was not until the beginning of the century that iron rails were laid and four wheels put on the wagon to carry coal out of the Welsh and English mines. And it was only in the 19th century that those great men George and William Stevenson put on their first locomotive and then were afraid

that little fellow Murdock was going to get ahead of them. I suspect you are still waiting for some one to get ahead of you, particularly those Interstate Commerce fellows.

Now I want to tell you about the development of something that is not quite so near to you, the wonderful development of chemical and physical science in those years that I have been associated with it. I can remember very well here in the city of Pittsburgh when Professor Barker came from the city of Philadelphia and showed the first spectrum that had ever been seen in this city. That was before the days of Langley. And when you think what has been accomplished since then, in the domain of physical science it is simply marvelous. In the early days we hadn't anything but the atom. That is a big thing now, but then it was the smallest thing known. What is an atom today? Take a drop of water and build it up and up until it is the size of the earth; then take an atom and build it up and up until we get it raised in the same proportion that we have raised the drop of water, then will the atom be some place between the size of a marble and a cricket ball. Take the largest atom we know, the hydrogen atom, according to the new corpuscular theory it can be broken into nearly 900 parts, every part having an energy that is inconceivably great; can our finite minds grasp what science has told us in realtion to the corpuscle or the ion or electron that forms the basis of the atom? One of my friends has estimated mathematically and physically that if you break the hydrogen atom up into its corpuscles and take a thimble that will contain exactly a cubic centimeter, (about 1/3 cubic inch) and fill it full of the corpuscles of hydrogen, you can put into it 525 octillions. How many of you can write that in your notation? I don't know anything about such figures, and neither do you. But let us bore a hole in the thimble and let the corpuscles run out at the rate of a thousand a second it would take 170,000,000,000 of years to empty the thimble.

Take the radium atom. I had the use from my friend Lucien Scaife of a little spinthariscope in which was probably about 1/100,000 of a grain of radium, so small a quantity of the metal that no microscope could discover the size of the metallic radium in it. Yet that little atom of radium has to my knowledge been sending out its marvelous corpuscles and shooting

them against the screen at the base of it at the rate of perhaps 1,000 per second for nine years, and it will keep on doing that for 1750 years yet, and then will only be reduced one-half. Then it will only decrease one-half for 1750 years longer and so on. If we could only get a gram of radium and put its energy into this room for a single half minute not one of us would go out alive.

Physics has opened up a wonderful new field in every direction, and so has chemistry. Perhaps the chemist of the future will be able to make artificially pretty nearly everything that is made now in the natural way. You and I have read about the work of the alchemist, he that undertook to transform the baser metals into gold. Do you know that this has recently been accomplished, that it is possible to transform one metal into another? Not in large quantities, because we can not get large quantities of radium, but there seems little doubt that in the origin all things were composed of one single element. Now if one single transmutation is made possible by the action of forces we have at command now, what is going to come in the future?

The chemist can produce so many artificial substances in his alembic. I was in Washington not long ago and heard a very interesting paper on a new substance the writer had found to take the place of horn, turtle shell, celluloid and things of that sort which was made out of two simple chemical elements. I hope it will not come, after the nice luncheon we have had together that some time in the future we may take our luncheon in the form of a little pellet so that we can go on and do our work without interruption. Chemistry is doing many things of value today. Take the analine dyes alone, made of ordinary dirty coal tar. Lord Kelvin said dirt was only matter in the wrong place. When I look up at yonder magnificent cluster of stars what do I study it with? A bit of glass. What is glass? A bit of dirt, a bit of sand, a bit of lime, and sodium. If it gets in your eye you make an awful fuss about it. But when it is put in the right place in the form of a glass lens and turned up to yonder sky, what beauties it brings to our vision.

Here is a little piece of transparent salt. It is the same kind of salt we had at our luncheon. It may be a little purer, although it does not pay to adulterate salt because it is so cheap.

With this substance and with a physicist or chemist manipulating it the great story of the possibility of organic life on the earth has been solved. When the investigation was made with quartz, pure and beautiful as it is, the radiations that make life possible would not pass through it. When the purest glass was used we could not find anything that would tell us the story. It is not the light we see coming from the sun that conserves life upon the earth. If we had nothing but that which we see coming from the sun in the form of energy that we call light, it would be impossible for you and me to have existence. Plants could not live, nothing could live on the face of the earth, so far as we know. We find that by making prisms and lenses out of rock salt—Tyndall first found it—that the low radiations that come from the sun, the long rays that come into the earth's atmosphere, are the waves that can not get out again. Why? Our atmosphere is so constructed that it will only conserve these long radiations, and make organic life possible. You and I get into bed on a cold night pull on the covers and think the covers warm us. They have no warmth in them. It is the warmth of the body that is kept from being radiated which keeps us warm, heat from the stuff we have eaten for dinner that has been conserved by our blankets. It is this kind of radiation coming from the sun — that our atmsophere conserves and makes organic life possible. So simple a thing as a little piece of rock salt transformed into prisms and lenses has been able to teach us how these low radiations are kept in by this wonderful atmosphere of our earth. Why is it that the tops of the high mountains are covered with perpetual snow yet they are nearer the sun than the valleys. Simply because they have not enough of this blanket of the atmosphere to conserve these low radiations. These radiations so important to we mortals have been studied and measured by a wonderful instrument called the bolometer, (bolos, heat; metros measure).

When I started in my humble way up on the South Side hills carrying my telescope that my wife and I had made after three years labor, to see the first comet through it, there was not so much known about astronomy as we know today. The astronomy of measurement was known fairly well. Many efforts had been made to find the nearest star we have in the

heavens and the only star that was successfully measured was a star, that we can not see in this latitude, but it can be seen as far north as Carolina, the star Alpha Centauri. There are quite a number of engineers here who know the value of a big base line in making a measurement. The bigger the base line the more certain the result. If I had a 50′ steel tape line I could measure this room more accurately than with a 1″ measure. What is our base line to measure the nearest star? It is not the diameter of the earth, that is useless. The telescope with its precision is placed upon a star on the first of June and a hundred or so measurements made with great precision. Not the precision with which you would measure the railroad lines, but probably a hundred times more accurate. Then we wait until this old earth has gone around her orbit half way and she is twice 93,200,000 miles from where she was and the base line is 186,400,000 miles. Yet when the telescope is placed upon that nearest star again on the first of December it only has to be moved 1/2,000 of the diameter of the moon, or less that one second of arc on that immense base line. And that for the nearest star. In other words the latest measurements give us the distance of Alpha Centauri to be 25,000,000,000,000 of miles. It is about twice as big as our own sun and light takes about 4½ years to reach us. And if we were running a railroad train at 60 miles an hour, to reach that star it would take us 47,000,000 of years. And if we had to pay our fare at the rate of 2 cents a mile our ticket would cost 500 billion dollars. If some one were singing on our sun and it was possible to hear the song sound traveling at the rate of 1120′ in one second would take nearly fourteen years to reach us. But if the song were being sung in the star Alpha Centauri, the nearest star, it would take a little over four million years before we could hear it.

You engineers have a delicate cross wire in your theodolites. That line is usually made out of a spider's cocoon. Not the web, that is too coarse, but the cocoon in which the spider lays her eggs and hatches her young. After the little fellow goes out into the world we take the cocoon and unravel it and stretch it out for those delicate cross lines. There have been attempts to make it out of quartz, but it never yet approached the delicacy of the spider line. We have a good kind of spider

here in western Pennsylvania and eastern Ohio from which we get these webs. Stretch it under the microscope for any length and you will not find the least deviation from exact thickness in it. One of my boys came to me one day and said "I have been measuring a lot of those spider lines and weighing them and I have developed an interesting story. If we could get enough of the spider line to stretch around the earth, and then roll it up in a ball, it would weigh about one pound. The earth is about 25,000 miles around. If we could get enough to reach to the moon, 240,000 miles, it would weigh about 9.6 pounds. If we could get enough to stretch to the sun, 93,200,000 miles, it would weigh 3720 pounds. If we could get enough to stretch to the star Alpha Cenaturi it would weigh, on the basis of one pound to stretch around the earth, 500,000 tons. If you could compact it into a solid mass that you could put on your good freight cars of 50 tons capacity each, it would take 10,000 freight cars to carry it, and yet Alpha Cenaturi is the nearest star.

We did not know how to measure any of the farther stars until another invention came in to help us. This is an instrument called the spectroscope. Light passing from any body that is giving out gaseous emanations, like a Bunsen burner or an electric arc, after passing through a prism of glass is bent and spread out like a fan, forming the familiar colors of the spectrum, red, orange, yellow, green, blue, indigo and violet, and the presence of the various elements are indicated by lines in this spectrum. If we take an electric arc we will find carbon and copper in it, indeed every element burning in the arc has its peculiar lines. Every one of these lines in the spectrum indicates that something is burning in the object. It does not make any difference whether it is an electric arc or a burning star which may be so far away that its light takes a thousand years to get here, traveling at the rate of 186,000 miles a second. These delicate lines are always exactly in the same place with the same instrument within a millionth of an inch under the same conditions. Suppose it is lines indicating iron. If I find they are shifted a little when I am looking at a star from where they are when I am studying an arc I know is stationary, what does it mean? If you have a train running 38 miles an hour going past the station blow-

ing the whistle, just as it passes the station, down goes the pitch of the whistle a whole tone. It is not the whistle that is changed, but if the train is running away from you it is stretching the vibrations apart and the longer vibrations always produce the lower tones. If you had a tuning fork and could get the exact tone of the whistle as the train came and as it passed by, you could tell exactly how fast the train was going by figuring the difference in the vibrations required to produce the two different tones.

Out yonder is a star that is coming toward or going away from us. All we have to do is to turn the spectroscope on it and watch the shifting of the lines and compare it with something of the same character right in front of us burning and standing still. We can thus tell just how fast the star is moving and whether it is coming toward us or going away from us. When one star is revolving around another—and there are thousands of them in the universe—we can tell how fast it is going around, and by the law of gravitation we can tell how far in miles it has to be away to go that fast. Then all we have to do is to measure in angle the separation of the star from one that it is moving around and we can tell how far away it is. The stars in the belt of orion are more than 4,000,000,000,000,000 miles away from us. Away out yonder in the universe by the aid of the great telescope at Mount Wilson, stars may be found of the 21st magnitude and in all probability, unless there is some absorbing medium in space, those stars are not less than a million light years away from us. 1,000,000 years multiplied by 365½ days multiplied by 24 hours multiplied by 60 minutes multiplied by 60 seconds and then multiplied by 186,000 miles, and you have the distance in miles.

I compute that we have for our own place in the universe a cubic sphere of 15,438 with 38 cyphers to the right or 15,438 duodecillions of miles. I computed how much of a cube we would put in Lake Erie, 250 miles long, 50 miles wide and an average of 100 feet deep, to represent the same cubic content that we have for our solar bailiwick. The cube would be 1/7,000 of an inch in diameter. So we have plenty of room. But we know that we are going through this old universe straight out toward the constellation of Hercules 12½ miles every second of time and while we have been sitting here we

have been traveling on God's railroad that never runs off the track a very great distance, but sometime we may run into another train and then the smash is wonderful indeed, smashing both worlds into the primordeal gaseous state. And yet as you and I travel 984,000,000 miles every year around the earth, around the sun and out into space we must conclude that this old world of ours is a mighty safe train to run on. She keeps good time, yes, makes her stations to the second.

I have only just skimmed over the wonderful things that have come in my lifetime, beautiful things that you have a right to know about and that you all may see in the beauty of God's great universe. God bless you all.

MR. FRANK J. LANAHAN: I would move that a rising vote of thanks be extended to Dr. Brashear for his talk, not only scientific and masterly, but full of the manifestation of brotherly love. I know there are not many here who are not acquainted with the splendid evidences and the famous revelations he has given of his consideration for every phase of humanity. And, gentlemen, listening to such wonderfully complex matters described in such simple language, those subjects which could so easily be made hard to understand, by the facile use of definite, technical terminology, we recognize the master mind, endeavoring to add to the sum of our knowledge and not boasting of the greatness of his own. To me he comes close to meeting the poet's ideal that

> True worth is in being, not seeming
> And in doing each day that goes by
> Some little good—not dreaming
> Of the great things to do by and by."

I wish to move a rising vote of thanks that shall manifest to Dr. Brashear our admiration and deep affection in which he is held in the hearts of not alone The Railway Club of Pittsburgh but of the whole city as well.

The motion prevailed by unanimous vote.

DR. BRASHEAR: I wish to thank you for listening to me so kindly.

There being no further business,

ON MOTION, adjourned.

J. B. Anderson
Secretary.

In Memoriam

JOSEPH A. SHREMP

DIED

FEBRUARY 19, 1914

OFFICIAL PROCEEDINGS

RAILWAY CLUB OF PITTSBURGH

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Annual Report of Standing Committee on Revision of Master Car Builder's Rules of Interchange by Mr. R. L. Kleine, Chairman—Address by Mr. Julian Kennedy.

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OF
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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, MARCH 27, 1914.

The regular monthly meeting was called to order by Vice President, Mr. F. M. McNulty; at the Monongahela House, Pittsburgh, Pa., at 8 o'clock P. M.

The following gentlemen registered:

MEMBERS.

Amsbary, D. H.
Anderson, J. B.
Antes, E. L.
Austin, F. S.
Babcock, F. H.
Bailey, R. E. L.
Barth, J. W.
Battenhouse, Wm.
Beebe, I. L.
Berghane, A. L.
Blair, H. A.
Boyer, C. E.
Bradley, W. C.
Brownscomb, G. J.
Brunner, F. J.
Butler, W. J.
Cassiday, C. R.
Chapman, B. D.
Chester, C. J.
Christy, F. X.
Cline, W. A.
Conner, W. P.
Cooper, F. E.
Copeland, F. T.
Cotton, A. C.
Coulter, A. F.
Courson, C. L.
Crenner, J. A.
Cunningham, R. I.
Dambach, C. O.
Deagen, J. J.
DeArment, J. H.
Dickinson, F. W.
Donovan, P. H.
Doty, W. H.
Dudley, S. W.
Duggan, E. J.
Elliot, Jos. M.
Emery, E.
Englert, A. F.
Felton, F. J.
Fettinger, H. O.
Fitzgerald, D. W.
Fogle, E. F.
Forsythe, G. B.
Fulton, A. M.
Gale, C. H.
Gearhart, J. A.
Gies, Geo. E.
Grewe, H. F.
Grooms, J. C.
Gross, C. H.
Grove, E. M.
Guy, W. A.
Harriman, H. A.
Haselett, D. H.
Hays, M. D.
Haynes, J. E.
Heird, G. W.
Henderson, J. W.
Herrold, A. E.
Hilberry, H. H.
Holt, Jas.
Howe, D. M.
Howe, Harry
Hoover, E. J.
Hurley, Theo.
Hutt, Frank
Jameson, A. A.
Kelley, H. B.
Kinter, D. H.
Kleine, R. L.
Knickerbocker, A. C.
Knight, E. A.
Koch, Felix
Koll, J. F.

Kurzhals, C. L.
Lanahan, J. S.
Lanning, C. S.
Lansberry, W. B.
Laughner, C. L.
Lindstrom, T. J.
Loughner, M. F.
Laylin, M. A.
Lehr, H. W.
Lewis, O. J.
Long, R. M.
Lyle, D. O.
Lynn, Saml.
May, F. J.
Maylock, E. A.
Mensch, E. M.
Miller, F. L.
Mitchell, John
McAbee, W. S.
McCurdy, C. E.
McDermitt, W. W.
McKee, R. R.
McNaight, A. H.
McNulty, F. M.
Nelan, E. J.
Parke, F. H.
Parks, O. J.
Porter, H. V.
Proven, John
Rabold, W. E.
Ritts, W. H.
Rohn, W. B.
Ryan, Wm. F.
Sarver, G. E.
Searle, J. M.
Sheets, H. E.
Shumaker, F. S.
Smith, J. H.
Smoot, W. D.
Snyder, Jos.
Stark, F. H.
Stumpf, F. L.
Suckfield, G. A.
Summers, J. R.
Swayne, H. B.
Taylor, F. C.
Thomas, E.
Thomas, J. H.
Towson, Thos. W.
Trautman, H. H.
Ulmer, E. F.
Walther, G. C.
Ward, R. H.
Wertz, Peter
Wescoe, F. B.
White, F. L.
Williams, W. W.
Williamson, J. A.
Wood, R. C.
Wyke, J. W.
Yungbluth, B. J.

VISITORS.

Blake, F. H.
Boring, T. J.
Bradley, Jas. A.
Delaplane, J. L.
Evans, H. C.
Evans, T. J.
Elkin, W. C.
Ferguson, J. C.
Gross, C. H.
Hahessey, Thos.
Hobson, H. A.
Hobsinger, F.
Humphrey, C.
Hunter, J. A.
Huston, F. T.
Jay, A. R.
Johnson, W. A.
Keim, S. H.
Kennedy, Julian
King, S. A. Jr.
Kimpel, H. C.
Kleine, Herbert, J.
Keyser, R. H.
Marroe, W. M.
Meagher, H. B.
Myers, A.
McCurdy, C. P.
McGinnis, P. B.
O'Malley, J. A.
Pfeiffer, C. A.

Porter, W. E.	Wahlert, H. A.
Ransbury, F. S.	Wharton, J. E.
Reynolds, D. E.	Wier, J. B. Jr.
Rothrock, W. P.	Wrigley, C. B.
Sitterly, W. H.	Wolfe, Geo. J.
Swank, G. E.	Wolfe, L. L.
Towsley, C. A.	Yergy, H. J.

VICE PRESIDENT McNULTY: Gentlemen, I have been requested to preside this evening owing to the absence of our President, Mr. Mitchell.

The roll call will be dispensed with, as we have a record of the attendance on the registry cards.

The reading of the minutes will also be dispensed with, as the proceedings of the last meeting are in print and will be mailed to you in a few days.

The Secretary will read the list of applications for membership.

SECRETARY ANDERSON: We have applications for membership from the following:

Boehm, Leonard M. Assistant Storekeeper Passenger Car Department Pressed Steel Car Co., 748 Boquet Street, McKees Rocks, Pa. Recommended by Harry Howe.

Elkin, W. C. Piece Work Inspector, Penna. R. R., Walnut and Sixth Street, Irwin, Pa. Recommended by M. F. Loughner.

Forcier, C. W. Storekeeper Pittsburgh Railways Co., Felicia Way and Sterret Street, Pittsburgh, Pa. Recommended by B. J. Yungbluth.

Heltzel, J. I. Gang Leader, Penna. R. R., 30th Street Shops, South Pittsburgh, Pa. Recommended by C. J. Chester.

Hunter, John A. Gang Foreman, Penna. R. R., 616 Sixth St., Pitcairn, Pa. Recommended by John H. Smith.

Johnson, E. A. General Sales Manager, Duff Manufacturing Co., Preble Avenue, N. S., Pittsburgh, Pa. Recommended by J. B. Anderson.

Lyons, Robt. S. Salesman, National Lead & Oil Co., 14 Ellzey Street, Pittsburgh, Pa. Recommended by J. B. Anderson.

Porter, W. E. Assistant Chief Smoke Inspector, City of Pittsburgh, 6908 Bennett Street, Pittsburgh, Pa. Recommended by J. W. Henderson.

Straub, V. Vanderbilt R. R. Rep. Star Brass Manufacturing Co., Crawford House, Boston, Mass. Recommended by F. M. McNulty.

VICE PRESIDENT: These applications will be referred to the Executive Committee for their approval, after which the gentlemen will become members.

SECRETARY: Mr. President, the following announcement was handed to me this evening by Mr. Stephen C. Mason, Secretary of The McConway & Torley Company.

> "Complimentary concert to the members of The Railway Club of Pittsburgh and lady friends by The Pittsburgh Male Chorus, James Stephen Martin, Director, in Carnegie Music Hall, Thursday evening, May 14th, 1914, by courtesy of The McConway & Torley Company."

Mr. Mason asked me to make this announcement and later on, or in due course of time, the usual invitation will come out to the members with request that you advise the Secretary how many tickets you will want for this concert, which you understand is complimentary and free.

VICE PRESIDENT: If there is no further business we will hear the annual report of the Standing Committee on Revision of Master Car Builders Rules of Interchange by Mr. R. L. Kleine, Chairman.

MR. R. L. KLEINE: If it is agreeable I will simply read the most important changes that the Standing Committee on the Revision of M. C. B. rules of Interchange made. While we consider all the changes recommended as important, at the same time some are of minor importance, whereas others are main objects for the change; and if it is agreeable, Mr. President, I will just read the most important of the changes.

There being no objections, Mr. Kleine proceeded to read the report.

ANNUAL REPORT OF STANDING COMMITTEE ON REVISION OF M. C. B. RULES OF INTERCHANGE.

Mr. President and Gentlemen:

Your committee is pleased to note the increased interest shown by the members of The Railway Club of Pittsburgh in the Master Car Builders' Rules of Interchange by the numerous replies received, as compared with former years, to the circular issued by our Secretary under date of February 14th, 1914, asking for recommendations for changes in the interchange rules. All of the replies received have been carefully considered and those approved by your committee are included in the recommendations, herewith, presented for your consideration.

The meeting of your committee was held at the Monongahela House, Pittsburgh, Pa., February 26 and 27, 1914, and aside from the rules of interchange subjects of car construction, shop practices and inspection was discussed which is a direct benefit to the representatives of the roads centering in Pittsburgh, in that a more uniform and comprehensive understanding of the prevailing conditions on the various roads is obtained by the representative members.

Mr. W. P. Richardson, Mechanical Engineer, of the Pittsburgh and Lake Erie Railroad, was introduced by Mr. Samuel Lynn, Master Car Builder, P. & L. E. R. R., and at the request of the National Tube Company presented a blueprint on standard stake pockets and their location on gondola cars of 46 feet inside length, with provision for using standard size of stakes without necessity of fitting to pockets, for pipe loading, with a view of having same adopted by the M. C. B. Association.

The Chairman was instructed to write the National Tube Company that this committee had given the matter very careful consideration and direct their attention to the fact that the M. C. B. Association now has a Recommended Practice for "Temporary Stake Pockets" also a Recommended Practice for "Longitudinal Spacing of Temporary Stakes" (See Page 1060 and Sheet M. C. B. "E," 1913 Proceedings) for which reason it is out of the scope of this committee to consider the same, and that the National Tube Company should present their views to the M. C. B. Committee on Rules for Loading Materials,

Mr. A. Kearney (Chairman), Assistant Supt. Motive Power, N. & W. Railway, Roanoke, Va. The Chairman of your committee directed our Secretary to write to the National Tube Company accordingly.

Messrs. Chas. A. Lindstrom, Ass't. to President and H. W. Elverson, General Foreman, Miscellaneous Order Department, representing the Pressed Steel Car Company presented several methods of loading mine cars in gondola cars, other than that covered by Rule 117-C and Fig. 61-A of the 1913 M. C. B. Loading Rules. After a discussion of the matter it was suggested to the representatives of the Pressed Steel Car Company that as this subject was under the direct supervision of the M. C. B. Committee on Rules for Loading Materials more expeditious and final action could be obtained by taking the matter up with that Committee.

A communication, addressed to Mr. J. B. Anderson, Secretary, was received from Mr. I. N. Kalbaugh, Supt. Motive Power, Coal and Coke Railway Company, dated February 17th, 1914, concerning side bearing clearance on cars. It was suggested that this gentleman be advised to take this question up with the M. C. B. Committee on Revision of Standards and Recommended Practice. Our secretary was instructed accordingly.

The Rules of Interchange were carefully considered by your committee and while no radical changes are suggested the modifications recommended are considered essential to keep pace with the changing conditions and are as follows:

RECOMMENDED CHANGES IN THE M. C. B. RULES OF INTERCHANGE.

RULE No. 9.

M. C. B. couplers, or parts thereof, R. and R. In the last line under bracket belonging to this heading omit the word "Stem."

Explanation: Cars so equipped are not acceptable after October 1, 1914, as per rules 18, paragraph 3, and 35, paragraph 2.

Metal brake beams, or parts thereof, R. and R. In the fourth line under the bracket belonging to this heading

change the phrase "Cause of renewal" to "Cause of removal."

Explanation: To have this correspond with other sections of rules where reference is made to parts "Removed" instead of parts "Renewed."

Page 7, 1st paragraph, 1st line. Insert "Comma" (,) after valve, omit word "Or" and add after cylinder the words "Centrifugal dirt collector."

Explanation: It is just as essential to show on the repair card the initial of the road and the date of last cleaning of the centrifugal dirt collector as is done at present for the triple valve and cylinder, in order to justify bill.

RULE No. 10.

Second paragraph, change to read: "In all cases of forged or rolled steel wheels, the actual thickness of tread before and after turning off, must be shown measured from base line of tread to the condemning limit of tread, which is ¼-inch above the witness groove, as determined by gauge shown on sheet M. C. B.—C-1 of Recommended Practice; also show actual thickness of tread on other wheels applied. This information must be reported to car owners regardless of whether or not repairs are chargeable to owners."

Explanation: The basis for measurement of thickness of tread should be on a full flange contour. The gauge adopted by the M. C. B. Association enables the road changing the wheels to determine the thickness of tread based upon a full flange contour before turning, thus enabling the handling of this matter uniformily and equitably.

RULE No. 14.

After second paragraph add a new paragraph as follows: "Cars equipped with two brake cylinders must be stenciled 'A' and 'B' ends."

Explanation: To enable repair cards being properly made by designating part of car according to "A" and "B" ends.

RULE No. 17.

Change third paragraph to read: "Pressed steel, cast steel, malleable and grey iron M. C. B. standards may be

substituted for each other, charges to be on basis of material applied and the credits on basis of material removed. Billing repair card must state kind of material applied and removed."

Explanation: To encourage use of all M. C. B. Standards and to remove penalty that prevails in old rule, when standards other than cast iron are used. Where a road applies material to foreign cars, in repairs, that conforms to the specifications and standards of the M. C. B. Association it is manifestly improper to penalize such road. By penalizing the use of such material it destroys the common use of the standards.

Following fourth paragraph, a new paragraph to be added, as follows:

> "After October 1, 1915, metal brake beams not conforming to M. C. B. specifications for No. 1 or No. 2 beams and so marked must not be used in repairs to foreign cars."

Explanation: To enforce use of M. C. B. specifications for standard beams Nos. 1 and 2, bring about a uniformity in repairs and reduce stock to be carried to a minimum.

RULE No. 18.

Eliminate second paragraph as couplers with stem attachments are not acceptable in interchange after October 1, 1914.

Change third paragraph to read: "Cars having couplers with stem or spindle attachments or American continuous draft rods will not be accepted in interchange unless home routed."

Explanation: To permit cars so equipped to move home to owners.

RULE No. 20.

First paragraph, add as follows: "Where construction of car and trucks precludes the common methods of adjusting coupler heights, the application of wrought or steel shims between top of journal boxes and underside of truck frames will be permissible."

Explanation: To provide for adjustment of coupler heights that cannot otherwise be taken care of.

RULE No. 21.

Add the following clause: "Also for applying temporary hand rails to flat cars with well holes not equipped with permanent hand rails."

Explanation: Car owners should stand the expense of making cars safe for trainmen when not equipped with a permanent arrangement of hand-railing.

RULE No. 22.

Add foot note after first paragraph of this rule as follows: "Short longitudinal sills which are not continuous from end sill to end sill will not be considered as longitudinal sills."

Explanation: At the present time there is a difference of opinion between inspectors of the different roads as to whether the stub, or short inter sills, should be considered as longitudinal sills and figure in combination defects.

RULE No. 33.

Add new rule in place of present vacant rule, as follows: "Cars equipped with United States Safety Appliances or United States Safety Appliances Standard and so stenciled, the renewal of or repairs to side and end ladder treads, side and end hand holds, sill steps and brake shafts, unless the brake shaft is bent or broken due to lading shifting. (Delivering Company responsible).

Explanation: Inasmuch as these safety appliances conform to a uniform specification and are applied in a standard manner it is considered that they cannot, as a rule, become defective except as a result of rough usage or lading shifting, it is recommended that the renewal of same be made a delivering company's defect.

RULE No. 35.

Eliminate first paragraph.

Explanation: Cars equipped with stem or spindle attachments will not be acceptable in interchange after October 1, 1914.

Change second paragraph to read: "Cars equipped with couplers having stem or spindle attachments or American continuous draft rods, will not be accepted in interchange unless home routed."

Explanation: To permit cars equipped with stem or spindle attachments or American continuous draft rods to move home to owners.

Eliminate last paragraph.

Explanation: This paragraph refers to trucks and should not be included in rules relating to bodies of cars. It is now covered under heading, Trucks, Rule 66.

RULE No. 37.

Make vacant Rules 37, 39 and 40 and change the words "(Rules 37 to 42 inclusive)" as now printed below the heading of the rules in question, to read: "(Rules 41 and 42)."

Explanation: The present combinations of damages for wooden underframe cars are unsatisfactory, as the existing rules are resulting in partial repairs being made to worn out parts of wooden and composite underframe cars, or delays occasioned to obtain the owner's authority for repairs to owner's defects or damaged parts, which, if repaired without the owner's consent, would result in the refusal of the bills. When complete and proper repairs are not made, it directly affects the safety of the car, for which reason the above changes are recommended:

RULE No. 42.

The first two notes after Rule No. 42 printed in small type should be eliminated.

Explanation: The combinations covered by these notes are removed from the rules by the elimination of rules Nos. 37, 38, 39 and 40.

Add a new note reading as follows: "Where cars are damaged in classification or switching and no derailment or raking is present the repairs thus occasioned will be considered car owner's defects unless they form a combination of defects."

Explanation: Under the present rules, the handling

company (commonly known as the delivering company) is responsible for damage done to any car by unfair usage, derailment or accident. The rules define unfair usage as follows: "Combinations of damages to cars with wooden underframes or composite wood and metal underframes which denote unfair usage, if existing at the same end of car and requiring repairs or renewals. (Rules 37 to 42 inclusive)." It will be noted that no mention whatever is made of damage by collision and it is the practice of some railroads to bill repairs to the car owner if the same do not form a combination of defects and the car does not show evidence of having been derailed or in accident. Whereas, other railroads keep a careful record of all damage in classification from a standpoint of discipline to car droppers exceeding a limited speed at coupling and use the accident reports in connection with billing for repairs in assuming any damage shown by these reports.

This resolves itself into what is an accident, which depends upon the construction and the physical condition of the car being handled, and the local yard rules in force governing the speed while coupling in classification. In order that there may be a uniform understanding between roads and to eliminate the present controversy, either the above note should be adopted or some other rule inserted in the Rules of Interchange to serve as a guide for uniformity and equity in billing for repairs of this kind.

RULE No. 43.

Omit present rule 43 and substitute the following:

All Steel Cars or Cars With Steel Underframes or Cars With Continuous Steel Center Draft Members, Having a Cross-Sectional Area of 16 *Square Inches or More.*

Damage to bodies of all steel cars or damage to underframe of all steel underframe cars or damage to cars with continuous steel center draft members, when necessary to repair, if caused by unfair usage, derailment or accident. (Delivering Company responsible).

Longitudinal sills, end sills and other steel parts of cars which become defective due to corrosion and which

were not damaged in accident. (When necessary to repair or splice or renew more than two center sills or two continuous steel center draft members, in combination with end sill, coupler or coupler pockets or front and back coupler stops, the owner's authority must be obtained before repairs can be made.) (Owners responsibility).

Note: The above combinations of damage will not apply to cars with a cross-sectional area of less than 16 square inches in the center draft members.

Explanation: The present rule covering responsibility for damage to steel center continuous draft construction is considered unsatisfactory and the above changes are recommended to more equitably cover the situation.

RULE No. 44.

Insert new rule as follows: "Tank cars having leaky tanks, unless such leaks were caused in wreck, derailment, cornering or raking."

Explanation: To define owner's responsibility in connection with leaky tanks.

RULE No. 47.

Change to read: "When two or more cars chained together, or any cars which require chains to handle them, or equipped with metal spacing blocks in compliance with M. C. B. Rules for Loading Materials, are delivered at an interchange point, the receiving road shall deliver to the delivering road at the time an equivalent number of switch chains or metal spacing blocks of the same size as those used on cars delivered, or, in lieu thereof, furnish a defect card for such chains or spacing blocks."

Explanation: Provisions have been made in the revision of this rule to protect roads using metal spacing blocks in conformity with the M. C. B. Rules for Loading Materials. At the present time metal spacing blocks on cars delivered in interchange are seldom returned to the originating road and no protection can be secured. This change in rule will also encourage the use of metal instead of wooden blocks, the latter being very undesirable as they frequently crush permitting lading to shift and requiring shopping of load for readjustment.

RULE No. 52.

Add new paragraph as follows:

"When it is necessary to use M. C. B. Temporary Standard Couplers to provide the clearance prescribed by the United States Safety Appliance Standards, if not stenciled as so equipped." (Owners responsible).

Explanation: To indicate to car repairmen and others the kind of coupler which must be used to maintain the safety appliances in conformity with the U. S. Standards.

RULE No. 57.

Cut of air hose and label on page 31 to be modified so as to show that label is located within 6″ of hose coupling.

Explanation: To harmonize cut with the M. C. B. standard specifications for locating label on air hose when mounted.

Change third paragraph to read: "No new hose shall be applied unless it bears the revised band label.

Explanation: To correct rule to date.

Change fourth paragraph to read: "M. C. B. standard hose now in service will not be penalized.

Explanation: To correct rule to date.

RULE No. 58.

Change first clause to read: "Missing air brake hose or cut by striking."

Explanation: To comply with arbitration decision No. 880 and indicate that air brake hose cut by striking is a delivering company responsibility.

RULE No. 60.

Add sentence to third paragraph of this rule as follows: "Old markings must be erased before new stenciling is applied."

Explanation: Two sets of stenciling are frequently found, owing to the failure to erase the old markings, which is confusing.

RULE No. 83.

Cut of Wheel Defect and Worn Coupler Limit Gauge

to have notch shown indicating 2″ measurement for flat spots on wheels.

Explanation: To provide for the gauging of the two-inch flat spot covered in Rule No. 68.

RULE No. 87.

Eliminate reference to Rule No. 35.

Explanation: On account of eliminating first paragraph from Rule No. 35 with reference to application of pocket in place of stem attachments.

RULE No. 90.

Eliminate reference to Rule No. 35.

Explanation: Account of eliminating first paragraph in Rule No. 35 with reference to application of pocket in place of stem attachments.

RULE No. 98.

Page No. 51. The portion of paragraph from the start to first comma to be changed to read as follows: "If new wheels and axles are substituted for average credit price wheels and second-hand axles, (remainder of paragraph as now in effect)."

Explanation: This change is made to harmonize with average credit price for wheels, instead of second-hand and scrap wheels.

Page No. 52. "The price of forged or rolled steel wheels shall be based on the scrap value of $4.50 for the metal inside the condemning limit, which is ¼″ above the witness groove, plus 62.5 cents for each 1/16″ of service metal (on radius of tread) outside of condemning limit. No more than 1½″ service metal can be charged for."

Explanation: This eliminates the price of $19.50 for a new wheel from table on page No. 51. The new price recommended is applicable to new wheels, scrap wheels and second-hand wheels. At the rates given above a new wheel with 1½″ service metal would cost $19.50, no additional can be charged for wheels having service metal thicker than 1½″."

Page No. 52, Delivering Line Defects. This paragraph

to be modified by omitting the words "but no" in third line and substituting the word "and."

Explanation: Owners are benefited by increased service metal and it is but equitable that they be charged for the increase, if any, on the wheels applied in repairs. At present the rule works a hardship to the road changing the wheels as it is incumbent upon them, in order to avoid a dead loss, to apply wheels of equal or less service metal as was on the wheels removed.

Page No. 53, Delivering Line Defects. The first paragraph under this heading to be modified by placing a period after the word "owner" in seventeenth line and eliminate the remainder of the paragraph.

Explanation: Change is recomended as only the car owner is benefited by increased service metal in wheels.

RULE No. 101.

Page No. 55. Add: Cylinder front cap gasket (New York Triple), 15 cents.

Explanation: This is an item of frequent renewal and should be included in the price list.

Page No. 57. Add additional item after Triple Vent Piston, reading: "Other air brake material at catalogue prices."

Explanation: To indicate that catalogue prices are proper charges for other items not included in the list of prices in the rules. The items listed are based upon catalogue prices.

Page No. 57. Add the following item:

"Altering height of one end of car by the addition of wrought or steel shims between top of journal box and underside of truck frame, net, $2.00."

Explanation: Some cars on account of being of all metal construction, bodies and trucks, with center plates cast integral with bolsters, do not lend themselves to adjusting coupler height in any other manner. The shimming permitted over the bolster springs being insufficient to attain the desired result.

Page No. 58. Doors, all steel, for side or end of box or stock cars at manufacturers' price.

Explanation: The present prices for doors were made for wooden doors and do not cover all steel doors.

Page No. 58. Change item "Handhold, one, applied, net, 40 cents" to "Handhold or ladder tread, one, applied, net, 40 cents."

Explanation: As the ladder tread secured to car is practically the same item of work as a handhold, it is recommended that the ladder tread be included with the handhold under the same average price of 40 cents.

Page No. 59. Change item of spring cotters as follows: "Spring cotters or split keys, each, applied, when not used in application of other parts, 3 cents."

Explanation: When brake pins, knuckle pins, release valve rods, uncoupling clevises, etc. are applied, such application includes the application of spring cotters or split keys and the charge for such repairs is sufficient to absorb the trivial value of the spring cotter or split key. At present there is considerable controversy among billing clerks as to the propriety of the charge.

RULE No. 107.

Page No. 61. Omit the fifth item on page No. 61.

Explanation: Cars equipped with American continuous draft rods will not be interchanged after October 1, 1914.

Page No. 64. Bolts—"Journal box bolts or column bolts, in same truck, one, replaced" change to read: "Journal box bolt or column bolt, one, replaced 1½ hours."

"Each additional replaced in same truck, ½ hour."

Explanation: At present these items do not read correctly.

Page No. 64. After item "Carline, one, renewed" introduce new item: "Carline, one, replaced when out of place, 1¼ hours, 35 cents for ordinary cars."

Explanation: To provide a price for replacing a carline when out of place. The price for renewing does not apply.

Page No. 64. Center pin (key).—Add after the word "Key" the words, "Or plain."

Explanation: To provide for the plain center pin which is not now covered.

Page No. 64. Omit last item on this page "Coupler, with stem attachments, etc."

Explanation: Cars equipped with stem attachments and American continuous draft rods are not acceptable in interchange after October 1, 1914.

Page No. 67. Add item "Journal box lid, only, ½ hour."

Explanation: To provide a price for application of Journal box lid by itself.

Page No. 68. "Renailing roofing and siding per lineal foot," change to read: "Renailing roofing, siding and lining per lineal foot."

Explanation: Lining has been added.

Page No. 68. Add at bottom of page: "Running board, to secure with screws, (when running board is not renewed), per lineal foot of single board, 1 cent."

Explanation: To provide for running boards previously nailed.

Page No. 70. Add new items after fifth item on this page: "One intermediate sill, short, for hopper cars, renewed, 14 hours."

"Each additional intermediate sill, short, for hopper cars, renewed, or when longitudinal sills are renewed at some end of car 2 hours."

Explanation: We have no price at present covering renewal of short intermediate sills.

Page No 72. Add item: "Truck spring, replacing, one or cluster, when out of place, empty car.

One end of bolster, 1 hour.

At both ends of bolster, 1½ hours."

Explanation: To provide for a uniform price in replacing truck bolster springs on an *empty* car which is not covered at present.

Page No. 72. "Truck truss rod, center, one, renewed 10 hours." Change time allowance to 8 hours.

Explanation: The allowance for truck bolster is 9 hours and the truck truss rod which is a part of the bolster should be less than the complete bolster.

RULE No. 116.

Change first paragraph to read as follows: "The settlement prices of new eight-wheel cars shall be as follows, with an addition of $27.50 for each car equipped with 8-inch air brake equipment and $35.00 for 10-inch air brake equipment. Where the cost per pound is given as a basis for settlement the new weight of car body (including weight of air brakes and all parts attached to body of car as originally and completely built) is to be used in order to simplify calculations. The road destroying a car may elect to return the air brake apparatus as usually furnished by the air brake manufacturer, complete and in good condition."

Explanation: The above addition is recommended to make clear what parts are included in weights where per pound basis is used for settlement.

Page No. 86, second paragraph, change to read:

"When cars are equipped with metal center sills, or with continuous metal draft members consisting of continuous metal draft members and metal bolster, the following prices shall be added to the values of bodies for cost of such constructions:

Center sills less than 10 inches deep,	$ 60.00
Center sills 10″ deep or more,	80.00
Continuous metal draft members, consisting of continuous draft members and metal bolsters or metal diaphragms, the center sills having a cross-sectional area of 16 square inches or over,	140.00

Explanation: A large number of cars are being equipped with a substantial metal center draft arrangement in combination with metal bolsters or diaphragms, and where this construction has an approved cross-sectional area the car owners should be reimbursed for the additional money invested in such improved construction.

RULE No. 120.

This rule is not satisfactory. Inasmuch as it is governed partly by the M. C. B. Association and partly by the Car Service Association, your Committee recommends that a joint committee be appointed to revise this rule so as to provide for the most expeditious and convenient way to dispose of wornout and damaged cars.

RULE No. 122.

Last two paragraphs change to read: "The company having the car in its possession at the time shall provide from its own stock the following:

"Lumber, forgings, merchant structural shapes and bars, hardware stock, paint, hairfelt, piping, air brake material and all M. C. B. Standard material."

Explanation: The rule has been revised to include "Merchant structural shapes and bars" which can be obtained in the open market and, therefore, should be furnished from the stock of the railroad company handling car rather than delay repairs to obtain this material from car owner.

In conclusion your Committee desires to express its thanks to the members for the valuable suggestions received, also its appreciation to the Club for the entertainment of the Committee during its stay in Pittsburgh while engaged in formulating its report.

Respectfully submitted,

C. E. BOYER,
Pennsylvania Railroad, Lines East of Pgh.

G. E. CARSON,
N. Y. C. & H. R. Railroad.

S. A. CROMWELL,
B. & O. Railroad.

F. W. DICKINSON,
B. & L. E. Railroad.

H. F. GREWE,
Wabash Pittsburgh Terminal.

W. J. KNOX,
B. R. & P. Railroad.

S. LYNN,
P. & L. E. Railroad.
F. M. McNULTY,
Monongahela Connecting R. R.
O. J. PARKS,
P. F. W. & C. Railway.
J. B. SWANN,
P. C. C. & St. L. Railway.
F. H. STARK,
Montour Railroad.
R. L. KLEINE, *Chairman*,
Pennsylvania Railroad, Lines East of Pgh.

MR. KLEINE: I might say, gentlemen, you need not confine yourselves in the discussion to the various rules which the Committee has presented, but the Committee will be very glad to hear from any of the members on any that are not covered here, or answer any question within their power that may be raised. We may not be able to give you a satisfactory answer but will endeavor to throw light on any question that may now be in doubt.

VICE PRESIDENT: Gentlemen, the subject is now open for discussion. Those who care to take part Mr. Kleine is ready to answer anything he can.

MR. C. E. BOYER: In as much as there does not seem to be any questions, I move that the report embodying the changes in the Master Car Builders rules as recommended by the Committee be approved and forwarded to the M. C. B. Association.

The motion was seconded and unanimously carried.

VICE PRESIDENT: Now that we have dispensed with the regular subject of the evening, we will endeavor to entertain you for a short while by some instrumental and vocal numbers.

Mr. P. L. Crittenden, Mechanical Engineer, W. A. B. Co. then treated the audience with violin solo's and Mr. Lewis Garrett, Chief Clerk, to Supt. M. P. P. & L. E. R. R. with baratone solo's which were highly appreciated.

MR. F. H. STARK: I am sure we are having a most

delightful entertainment tonight. We have been honored in times gone by having prominent men speak to us, railroad representatives, men of affairs, experts, etc. We have had a very important paper presented tonight by Mr. Kleine. We might have stirred up some discussion on the question of interchange of cars, but the Committee have given two days' deliberation on the rules and it would be unwise for us to open up a general discussion with a view of possibly changing the recommendations. The Committee has weighed very carefully the whole subject and I believe we can well trust to their judgment. Mr. Kleine is one of the leading mechanical men. He is chairman of the Committee on the Master Car Builders Standard coupler, a committee work that is second only to the introduction of the air brake. It is an important task for a man so young to have on his hands, the leading of the manufacturers and railroad men together hand in hand with a view of adopting one single standard coupler throughout the United States, and will be an accomplishment that no one can measure.

We have had tonight a little diversion in the way of music, which we all appreciate. We had at our last meeting Dr. Brashear, and all of us who were fortunate enough to be present were thankful that we were here. Our Secretary in his notice stated that tonight there would be "something different," and I am quite sure that the speaker will not only entertain but instruct us, and if you will all agree to his ideas and go home and explain it to your wife I am sure that they will not object to your attending the Railway Club meetings if we consider such important subjects.

It is now my great pleasure to introduce to you one who has had more to do with the development of the steel industry than any other single man in the world. I introduce to you Julian Kennedy.

MR. JULIAN KENNEDY: Mr. President and Gentlemen of the Railway Club, I trust I may be able to accomplish the prophecy of the gentleman who introduced me as fully and as pleasantly as the musicians have fulfilled their part.

I am glad to be with you tonight as a Railway Club. I might say that I myself can claim to be a near railway man. I am a director in a railway, so-called a railway—The Cuyahoga

Valley Railway. Perhaps some of you know what that is. (Laughter).

There was a President of a railway once applied to the President of a great Transcontinental line for interchange of passes. The President who was asked for this interchange replied that he was a little in doubt about it. Your railroad is only two miles long, "it doesn't seem quite fair to exchange passes with a railroad a thousand miles long." The first President came back at him. "It may be true my road is not near as long as yours, but I am sure it is just as wide." (Laughter).

It has given me great pleasure to listen to the paper presented here tonight for several reasons. One is that it shows you railroad men are giving much study and great thought to the matters which make for your success in your chosen profession. I noted with interest one or two expressions of the speaker, one especially when he said certain rules were changed in the interests of more equitable charges—more equity between the parties to the contract. I am going to speak on some things tonight and I want to harp on that same thing.

There is a great change in the trend of public thought and public opinion in the last few years all over the world. And the most marked feature of this change is that we are dealing in large units. We are beginning to think more of the country as a whole; more of the interests of cities, villages and communities and not so much proportionately of the interests of the individual. We have lived largely in the past as in an individualistic age. We have been individaualists ourselves. We have all been working in a way that perhaps is laudable to a certain extent, to extend our own selfish interests and those of our immediate friends; but none have done as much as we ought to have done for our neighbors and for our communities. This is largely due to a property of mind and matter which is known as inertia. Now you know what inertia is—that property of matter that causes it to remain quiescent until set in motion and when set in motion to move in a straight line forever unless there are outside forces acting on it. And that force of inertia has some good qualities, also it may work to the disadvantage of all our interests, both individualistic and communistic. Inertia makes it hard to start things going that have not been going. It makes it hard to stop some things that have been going too

long. It is one of the hard features that we have to meet with in trying to better things in countries and in communities. Many of us do not realize I think the extent to which we are bound up in communities. Perhaps none of us realize the extent to which we are dependent upon each other. The man going out on the locomotive at the head of the limited express is dependent upon the dispatcher to see that he is not run into by something else on his way. We fail to realize how our lives are dependent upon the civic progress of the community in which we are located.

The railroads are beginning to let their men know that they must not drink. But what are the rest of us doing to help them? We pass laws demanding that if a man is hurt on a railroad the railroad must take care of him and then license about a hundred saloons around the station to tempt a man to get a drink before he steps on his engine and put his own life and and the life of his train crew in jeopardy. Gentlemen, the drunkard is not a bad man on the Pittsburgh and Lake Erie or on any other railroad. He is not the dangerous man. The dangerous man is the one who goes on his train with one beer or one whiskey. The man who cannot navigate properly across a platform is never allowed to go on his engine. If you go into a steel mill and see seventy tons of hot metal in a great ladle overhead do you suppose you would like to be one of the men working underneath if the man on the crane had one beer. Yet we as a community (and I will tell you why a few minutes later) will license saloons all around and tempt men who are going to handle this dangerous machinery to get one beer or one whiskey in him. And why do we do it? You ask any good respectable church member or any good respectable citizen who votes to encourage the saloon and he will tell you the big motive in his mind is the fact that the saloons pay a thousand dollars a piece for the privilege of running, and that helps the tax rate. Of course it does not help the tax rate—you men know that. I do not need to tell the intelligent men who have talked here to-night and the rest of you in the same line that there is no saving in that thousand dollars. It looks large when it comes in, but when you put two or three or four thousand dollars on the other side of the ledger against it, it does not look near so large.

Now we go all through without interests and we find we

are dependent on each other. You go out on the train, some of your railroad men, and two or three of you get mained and crippled, and the rest of you who do not happen to get hurt have to keep the ones that do. That holds good all through community. Those of us who are not crippled in the race of life have to care for the ones who are; those who are insane have to be taken care of by the others; those who are unable to help themselves have to be taken care of by those who are able to take care of themselves. If you were forming a crew to race on the river with a racing crew from one of our colleges you wouldn't put two or three chronic invalids in the bow of the boat and a fellow that was crippled at the stern and then go out and expect to win the race.

A few weeks ago the Iron Trade Review of Cleveland sent out circular letters—perhaps some of you men received them—reading something like this: "Owing to the radical reduction of the tariff on iron and steel, there will likely be very strong competition in this line in Germany. In view of this should we reduce wages, introduce more labor saving machinery or lower quality of product.

This last question deserves no answer. Of course it answers itself. You cannot compete by lowering the standard of your product and nobody but a fool would attempt to help himself in competition by lowering the quality of his goods. But that is a question that went out.

Now why is Germany such a formidable competitor in any line she goes into? Because she carries the minimum number of cripples in the boat. If you raked Germany with a fine tooth comb you couldn't find in any ten cities of Germany the condition you find in Marshalsea, connected with this city. They do not tolerate that sort of thing in Germany. You know that German Kaiser said the next war would be won by the people who use the least alcohol. There is no doubt about Germany being a hard competitor of anybody industrially. There is no doubt about Denmark being one of the most progressive countries in the world today, because they do not carry a large number of cripples and defectives in their citizenry.

Now why do we do it? We do it because for the last thirty or forty years we have all been so busy with our own selfish interests that we have not had time to think of the community

interests. You couldn't get a man to think of Marshalsea in this city or of the Western Penitentiary. We don't have time to go down and interest ourselves in that. We expect to elect a few officials and they will take care of all that without our thinking. We expect them to make bricks without straw. We expect them to run an institution on one hundred thousand dollars that requires five hundred thousand dollars, and then we give four hundred thousand dollars to something else that does not need it.

Now we are beginning to realize that our cost of living is growing so heavy it has become unbearable. Why? Because we have so many idlers, so many incompetents, so many insane, so many feeble-minded. You know in Pennsylvania cities one out of every sixteen is feeble-minded. And the number is increasing very rapidly. It is not a matter of how cheap we can make a ton of pig iron. A man can lie awake at nights for five years to get the labor cost on a ton of pig iron reduced from forty cents to thirty-seven cents, in the meantime giving no thought to economy in any public work.

Over in Allegheny we have two theological seminaries, one run by the Presbyterian Church and one by the United Presbyterian Church. Those of you who know anything about churches know there is no difference between those two churches at all except a slight difference in music. (Applause). They do not teach music in either seminary to any great extent, so that does not count. There are two seminaries teaching theology and the faculty of each one could teach the students of both. Some of them told me that, so this is not a guess. It is the same all over the country.

Now he have a lot of other things you railroad men have thought about along that same line, but not so bad, not so much to be deplored as that. But there is one good feature about that —one redeeming angle to it. You know that preachers in this country are a very much underpaid class of men. The average preacher's salary is only six or seven hundred dollars a year. We go into a small town and we see four churches around the village square and four preachers each one getting seven or eight hundred dollars a year. Now we say the average preacher's salary in this country is less than eight hundred dollars—a year —some say six hundred and fifty dollars—I don't know about

that. It isn't more than eight hundred dollars. Think of men of education, of character, of culture, expected to present a respectable appearance and educate their families on that sort of a wage. Now the redeeming feature of these little theological seminaries is this. They are not educating as many preachers as are dying. So that churches in a community whose creeds differ only in questions of musical taste each paying a preacher eight hundred dollars a year may be compelled in the near future to combine their forces and pay one preacher sixteen hundred dollars, which will be a little nearer a decent salary. When they do that the church will become an instrument for good, which unfortunately it appears not to be at the present time. (Applause).

Now you can go all over the matter of economics and civics and you will find lack of efficiency all along the line, duplication of effort; needless duplication of effort. You go out to a little village and you look over here on one side and you see a Western Union Telegraph office, down here a little farther on the other side a Postal Telegraph office. One operator could handle ten times as many messages as that little village receives. One line of wires could handle ten times as many messages as come through that village. There are two organizations kept up all over this country. Go down to New York and you see the great Western Union building and then a little farther down town you see the Postal and then half way between is the great United States Post Office. Any one of the three could run the whole business. Yet we wonder at the high cost of living. All that has to be paid for. We must remember it is not always the man that thinks he is paying for things that is paying for them. I had a man say to me the other day that he didn't believe that people who didn't pay taxes should be allowed to vote. I told him that is all right but who are these people you speak of that don't pay? If there is one thing that tires me it is to hear that the man that does not pay taxes should not vote. You and I have to pay taxes on property, but who pays the bulk of those taxes. The great bulk of the taxes are paid by the ordinary minimum wage laboring man or small professional man at a moderate salary. You take the Schenley estate and other estates, that own a large number of houses. The taxes are large but who pays them? The people in the houses of course. You go

out to the Carnegie Technical School. I told the boys out there once in a talk "you pay forty dollars a year for tuition." It takes four hundred dollars a year to educate a student. Who pays it? The laboring man who rides on the railroad pays it. I don't know whether any of your committee ever figured that out or not but it is perfectly plain. Some of the money that pays the interest on the steel bonds that endows that school is paid over the counters of the Railway stations largely by laboring men and women who ride on the railroad. I think it makes us all tired when we hear it said the fellow that does not pay taxes should not vote, because every fellow pays taxes, that wears woolen suits at least. (Laughter).

Now a good many years ago there was a certain eminent citizen of New York who in answer to a series of questions said, "What are you going to do about it." That is a pretty important question: What are you going to do about it. We labor under the delusion sometimes that we live under a democratic form of government. Of course we don't. But we live under a form of government which may sometime become democratic or approximately so. Of course those of you who have studied the question know that we are not as democratic as many countries. We are not as democratic as England. England has slipped a few cogs in the last week or two also. Now what is the remedy when near democracy or approximately near democracy does not work out well. The remedy, as a great many of you know, is more democracy. There are a great many disadvantages in living under a system which is intended to be democratic but which really is not. You all know about what is taught in our primary schools in regard to American government, American history and American politics. You all know the sentiments that prevail in our elementary histories about the greatness and goodness of America; we have the land of the free and the home of the brave, and all that sort of thing; and that one American is as good as another in this country and may be a little better. (Laughter). And that all have an equal chance, and so on ad nauseam. But every one of us knows that no man in this room until five or six years ago had any choice in the election of a President of the United States. Now you would hardly think that at first thought, but just think it over. Try to think of any time before the last five or six years when

any man in this room ever had any choice further than a choice between two men who were selected in some cases by twenty men in this country and who were put up for him to make his choice.

You have heard I suppose of a certain Irishman who came over here and become quite a political power. He said he didn't give a damn who voted for the candidates if he could nominate them both. And just a moment's thought will show you exactly how much power you have had beyond a choice between two evils in some cases.

Now, we are making a little progress in that respect. We have moved a little but we have moved slowly. Inertia is there, but in the words of the colored preacher, "The world do move" somewhat. We state on our "billboard" that all governments derive their just powers from the consent of the governed. That is a superstition that prevails at the present time. Now I have been President of the Men's League for Woman's Suffrage, previous to which I was President of the Equal Franchise Federation of Western Pennsylvania. Your good friend, Dr. Brashear is the incoming President of that League. The Men's League for Women's Suffrage—believes and wholly believes that a just government should derive its powers from the consent of the governed. My wife is very desirous of helping to govern herself in this country. She is infinitely more competent to do it than I am to help govern myself, let alone help govern both of us. (Laughter). Now what sort of a fraction of humanity would you consider me if I should say, "Oh, well, sometime it may be that will come; in the course of a few years that will come may be." I would be a kind of a vanishing fraction of a man if I would take that stand. Yet there are people that do take that stand. They feel they are better than their wives because they can vote. It is just about the only respect in which that sort of a fellow is ahead of his wife. (Laughter).

Now there are certain principles of equity which you have adopted in your rules of interchange. Look over the condition in the country. Look at New York. Look at her system of imprisonment of criminals. Most of you who know what is going on know that this is a great instrument of graft. You will remember that only a short time ago the new Mayor of New York City appointed a woman Superintendent of Charities and

Corrections in New York in charge of those tombs and other penal institutions in New York City. Those of you who have followed the current event of the day know that that woman has done more to increase the efficiency or to bring some efficiency into that plant than has been done by any twenty men who preceded her in the last thirty years. When Catherine Davis took hold of that plant Mayor Mitchell said, "There is a great deal of graft and a great deal of corruption in the tombs. Can you stop it?" Well, she said, "If you desire to have it stopped I will stop it." Certainly I do," said the Mayor." All right, I want five good men to go in there as prisoners and I want five men to go in as guards and I will find out what is going on and if there is anything crooked I will stop it. And she has stopped it as effectually as a train is stopped that goes into the snow bank, and just about as quick. And there was nothing mysterious about it. Any man could have done that same thing within the last twenty years if he had had the backing of his superior officer. But men are very apt to look at that thing in a very mysterious way. We art apt to complicate our problems.

A great many men in this room have no doubt served on boards with women. There are a number of you no doubt who have been on boards of charities and other boards, social uplift, made up jointly of men and women. I do not need to tell you that such a board of five men and five women will do much more work, other things being equal than a board composed entirely of men. Now are we going to withhold giving the one-half of our citizens in this country the right that they ought to have had in the beginning? The right bestowed by the creator? Are we going to stand back and withhold these rights or are we going to be men, decent, honest and fair and give other people the good things we have ourselves. I think men in the railroad business are men who are inclined to be fair as men who take their lives in their hands generally are.

I want the men of this Railway Club who believe, that the Creator has endowed women as well as men with certain inalienable rights to use their influence to help those people to get their rights. I have in my hand cards of membership in Dr. Brashear's Men's League for Women's Suffrage. That League has been in existence for about six or eight weeks. It

started with six members; it has seven hundred now. I want to have it up to three thousand before very long.

MR. E. M. GROVE: The members of this Club are indeed very fortunate to have had so eminent an engineer as Mr. Kennedy address us this evening. From a little experience we have had, if he had devoted as much time to the designing of an open hearth steel furnace as he has to his speech tonight and charged the Club at the same rate for it, it would knock the surplus in our treasury. Individually I want to say that his speech is just a little different from what I expected. It was advertised as being "something different," but starting in with a temperance lecture and covering the range from temperance to criminology, pauperism and women's suffrage, it was something different from anything that any of us expected I am sure. But he has given us all something to think about. His idea on taxes is undoubtedly correct. A man that buys a loaf of bread pays taxes just as well as the man who owns millions. We all pay taxes.

Under the circumstances I cannot help but feel that we are under a great deal of debt to Mr. Kennedy for his talk this evening, and we shall all go home feeling better for having been here and having heard it. I think a vote of thanks is due him from this Club, and I move that a vote of thanks be given him. And I want to include in this a vote of thanks for the gentlemen who really produced good music—the vocal music was all right and the "musical music" was all right. Furthermore, I cannot help but express the appreciation of this Club for the hard and earnest work that was done by the members of the Interchange Rules Committee. When this report was presented there was no discussion. It seemed to me that a matter so important we should have had a little discussion as it would have shown to the gentlemen who have taken so much pains and done so much work that their work was appreciated. But when there wasn't a voice raised, I will have to admit that it was just a little discouraging to the committee indicating that there had not been much thought given to the preliminary synopsis of the report which had been sent out, however, I feel sure you all appreciate what the work, that has been done, entailed.

A rising vote of thanks was tendered the Committee, Mr. Kennedy and the musicians.

MR. D. M. HOWE: Mr. President, it seems this would be no meeting unless I would have something to say. I had formulated some little things in my mind but Mr. Stark and Mr. Grove have taken all the glory. We have had some eloquent papers prepared and read before this Club, some very capable and able men have addressed us from the time of our organization up to the present, but I want to call your particular attention to the gentleman that addressed us at our last meeting and also to the gentleman who addressed us tonight. These two gentlemen have acquired national and international fame, and I am going to make a motion that Dr. John A. Brashear and Mr. Julian Kennedy be made honorary members of The Railway Club of Pittsburgh.

This motion was duly seconded and unaminously agreed to.

No further business the meeting adjourned.

J. B. Anderson
Secretary.

OFFICIAL PROCEEDINGS

RAILWAY CLUB OF PITTSBURGH

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"Braking Power" Its Interpretation and Its Application with Particular Reference to Passenger Service, by Walter V. Turner, Chief Engineer, Westinghouse Air Brake Co.

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OFFICIAL PROCEEDINGS

OF

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING.

APRIL 24, 1914.

The regular monthly meeting of the Club was called to order by President, A. G. Mitchell, at the Monongahela House, Pittsburgh, Pa., at 8 o'clock P. M.

The following gentlemen registered:

MEMBERS.

Adams, Lewis
Alexander, J. R.
Allison, John
Amsbary, D. H.
Anderson, J. B.
Babcock, F. H.
Balsley, W. T.
Barth, J. W.
Battenhouse, J. W.
Bauer, A. C.
Berghane, A. L.
Blackall, R. H.
Blakley, T. M.
Boehm, L. M.
Bradley, W. C.
Brunner, F. J.
Butler, W. J.
Caine, C. D.
Cassiday, C. R.
Chamberlain, W. A.
Chapman, B. D.
Chilcoat, H. E.
Christy, F. X.
Clark, C. C.
Code, J. G.
Cooner, L. D.
Cooper, F. E.
Cooper, W. M.
Copeland, T. T.
Coulter, A. F.
Cunningham, R. I.
Deagen, J. J.
Detwiler, U. G.
Doty, W. H.
Donovan, P. H.
Dudley, S. W.
Duer, Jas. J.
Duggan, E. J.
Elkin, W. C.
Emery, E.
Englert, A. F.
Falkenstein, W. H.
Felton, F. J.
Fogle, Emmett
Forcier, C. W.
Forsythe, G. B.
Frazier, E. L. Jr.
Freshwater, F. H.
Fulton, A. M.
Gallinger, G. A.
Gillespie, W. J.
Greiff, J. C.
Gross, C. H.
Guay, J. W.
Hagerty, E. D.
Hammond, H. S.
Hardman, H. J.
Harriman, H. A.
Harrison, F. J.
Haynes, J. E.
Hayes, M. D.
Herbick, N.
Heird, G. W.
Hill, J. F.
Hoffman, C. T.
Holbrook, W. H.
Holt, Jas.
Hopkins, H. V.
Howe, D. M.
Howe, H.
Hudson, W. L.
Hughes, J. E.
Hunter, J. A.
Hurley, Theo.
Hyndman, F. T.
James, J. H

James, Robt. E.
Jameson, A. A.
Jenney, Jacob
Johnson, W. A.
Kelly, H. B.
Kinter, D. H.
Knox, Wm. J.
Koch, Felix
Koll, J. F.
Kurzhals, C. L.
Lansbery, W. B.
Laughner, C. L.
Laylin, M. H.
Lichtenfels, P. H.
Lindstrom, Chas. A.
Lobez, P. L.
Lockwood, B. D.
Loughner, M. F.
Lynn, Saml.
MacQuown, H. C.
Mahey, Chas. G.
Maxfield, H. H.
Mensch, E. M.
Middlesworth, G. E.
Miller, H. M.
Mitchell, A. G.
Mitchell, John
Miyasaki, Y.
McAbee, W. S.
McCauley, Wm.
McCollum, G. C.
McIntyre, G. L.
McKinstry, C. H.
McNary, F. R.
McNulty, F. M.
McVicar, G. E.
Neff, John P.
Newell, E. W.
Newburn, T. W.
Obermeier, H.
Orner, M. T. S.
Painter, Jos.
Parke, F. H.
Parry, Wm. I.
Peach, W. M.
Pehrson, A. K.
Penn, Wm.
Pickles, H. D.
Pierce, H. B.
Pratt, I. D.
Pulliam, O. S.
Rabold, W. E.
Redding, D. J.
Rehlin, T. G.
Reymer, C. H.
Richardson, L.
Richardson, W. P.
Ritts, W. H.
Robbins, F. S.
Ryan, Wm. F.
Salkeld, R. C.
Sarver, G. E.
Schiller, John
Schuchman, W. R.
Schultz, G. H.
Sheets, H. E.
Sigafoos, Gus.
Slemmer, Wm. C.
Smith, D. W.
Smith, J. H.
Smith, M. A.
Smoot, W. D.
Snyder, J. R.
Spaeth, W. F.
Spielman, J. A.
Stevens, Cecil W.
Stewart, S. R. B.
Stoddart, W. G.
Stucki, A.
Stumpf, F. L.
Suhrie, N.
Sullivan, W. H.
Swayne, H. B.
Swope, B. M.
Thomas, C.
Thomas, J. H.
Thurlby, A. R.
Towson, F. W.
Trappe, W. C.
Trautman, H. H.
Travis, J. H.
Tucker, J. L.
Turner, W. V.
Walther, G. C.
Wardale, H. G.
Wardale, N. H.
Watkins, G. H.
White, F. L.

Williamson, J. A.
Woernley, H. F.
Wood, Ralph C.
Wyke, J. W.
Yungbluth, B. J.
Zinsmaster, F.
Zortman, C. E.

VISITORS.

Anderson, H. T.
Bailey, L. F.
Bair, A. H.
Bausman, G. A.
Boiselle, R.
Bouger, G. M.
Breed, P. H.
Brown, R. W.
Brown, W. T.
Buechner, E. L.
Burgess, T. S.
Burgett, J. C.
Burson, H. A.
Buvinger, W. S.
Camplin, H. F.
Caton, S. W.
Clark, H. B.
Cleland, H. W.
Crittenden, P. L.
Cunningham, C.
Devine, C. F.
Dewson, E. H.
Donaldson, H. C.
Doorbar, J.
Eckles, W.
England, A.
Englert, H. J.
Eriksson, E.
Evans, E.
Fatkin, E. S.
Fell, J. A.
Fleming, H. W.
Fleming, L. T.
Halleran, H. J.
Hamilton, H. R.
Hammerstine, R.
Hansenn, R.
Hannes, E.
Hays, O. B.
Henry, J. W.
Hesse, S. H.
Holbrook, C. R.
Hunter, E. L.
Huchel, H. G.
Jay, S. R.
Keller, C. H.
Key, B. F.
King, S. A. Jr.
Kopf, S.
Krimmel, H. E.
Lamon, J. A.
Leonard, D. E.
Lawrence, C. H.
Leonard, L. R.
Lowery, Jos.
Martin, R. B.
Mayhew, E. A.
Messick, C. A.
Meyer, L. A.
Milby, T. A.
Miles, L. P.
Minsker, J. W.
Miles, C. B.
Miller, B. W.
Moeller, L.
McGuire, S. H.
McMannus, W. J.
McMaster, W. R.
McSweeney, T. R.
Newcomer, W. S.
Noah, W. J.
Nordenmalin, H.
Osbourne, A. S.
Otterson, O.
Patterson, I. J.
Pattison, R. C.
Pennington, F. N.
Pesioz, J.
Rhodes, E. M.
Richards, W. J.
Roberts, D. A.
Roemer, M.
Ross, Alex
Rowley, C. E.

Sarver, B. T.
Schoonecker, F. B.
Schuer, L. D.
Schneider, C.
Swartzwelder, R. C.
Swann, E. J.
Schroyer, J. R.
Scott, Jos.
Scott, W. L.
Seitzell, F. O.
Sheehan, J. F.
Sheriff, B. F.
Simonson, S.
Smith, E. M.
Smith, G. M.
Sneck, H.
Snyder, Geo. F.
Speer, Jos. M.
Steinert, E. G.
Stem, G. A.
Stonerod, C. H.
Sutherland, J. I.
Tate, Robt. E.
Tempe, J. S.
Test, H. M.
Thomas, T. H.
Thompson, F. A.
Thomson, Wm.
Trist, N. B.
VanDalsen, G. A.
Vowinkel, F. F.
Wahlert, H. A.
Wallace, Chas. L.
Weaver, E. H.
Wood, E. R.
Wright, J. B.
Yawman, C. A.
Yohe, J. K.
Young, W. J.

PRESIDENT MITCHELL: The call of the roll will be dispensed with, the attendance being recorded on the registry cards.

The reading of the minutes of the last meeting will be dispensed with, the Official Proceedings being already in print and mailed to the members.

The Secretary read the following list of applications for membership:

Caton, S. W. General Car Inspector, Western Maryland R. R. Hagerstown, Md. Recommended by Samuel Lynn.

Huchel, Henry G. Draftsman, Pressed Steel Car Co., 807 Russellwood Avenue, McKees Rocks. Recommended by H. Howe.

Johnson, Walter A. Pneumatic Tool Manager, Ingersoll-Rand Co., Farmers Bank Building, Pittsburgh, Pa. Recommended by Geo. B. Raser.

Krimmel, Howard E. Mechanical Draftsman, Pressed Steel Car Co., 145 Dunbar Avenue, Bellevue, Pa. Recommended by H. Howe.

Mellon, W. B. Assistant Enginehouse Foreman, P. R. R., 333 Barnes Street, Wilkinsburg, Pa. Recommended by C. T. Hoffman.

Neel, T. M. Draftsman, Pressed Steel Car Co., 340 Woodward Avenue, McKees Rocks, Pa. Recommended by H. Howe.

Ord, L. C. Assistant Master Car Builder, Canadian Pacific Ry., 320 Prince Albert Avenue, Westmount, Montreal, Canada. Recommended by R. L. Kleine.

Pattison, R. C. Mechanical Engineer, W & L. E. R. R., Brewster, Ohio. Recommended by F. T. Hyndman.

Phillis, W. A. Assistant Advertising Department, National Tube Co., 2755 Stafford Street, Sheridan, Pittsburgh, Pa. Recommended by W. H. Ritts.

Putney, F. C. Supervisor, Penna. R. R., Freeport, Pa. Recommended by U. G. Detwiler.

Smith, E. M. Clerk, Union R. R., 91 Hazelwood Avenue, Pittsburgh, Pa. Recommended by A. F. Coulter.

Watson, W. N. General Foreman Machine Shop, Pressed Steel Car Co., 2700 California Avenue, N. S., Pittsburgh, Pa. Recommended by H. Howe.

Young, Wm. J. Draftsman, Pressed Steel Car Co., 117 Dunbar Avenue, Bellevue, Pa. Recommended by H. Howe.

PRESIDENT: As soon as the Executive Committee has favorably passed upon these applications the gentlemen will become members.

SECRETARY: Mr. President, I have received the following communication, to which I have replied and upon which some of our members have made some remarks, as follows:

Adrian, Mich., April 14, 1914.

Mr. J. B. Anderson,
Secretary, The Railway Club of Pittsburgh.

Dear Sir:

On receipt of the Official Proceedings of The Railway Club of Pittsburgh of February 27th, 1914, I was so much interested in the address of Dr. Brashear that I would like a copy for a friend of mine. Please find 20 cents enclosed and stamp to pay postage. I never fail to read the proceedings of your meetings. You probably don't know me, but Messrs. L. H. Turner and F. H. Stark do and while not a visitor at your Club meetings I still feel an interest in the proceedings of your meet-

ings. I commenced railroad service in 1848 when things were quite primative, witnessed the change from the strap rail to laying T rail of 44 pounds to the yard and it was said then that would be the end of repairs, in fact it was only the beginning. I was 90 years old last October, my health is good but as you will observe from this writing my hand is not quite as steady as it once was.

Sincerely yours,

JOHN KIRBY.

Pittsburgh, Pa., April 16, 1914.

Mr. JOHN KIRBY,

Adrian, Mich.

Dear Sir:

As requested in your letter of the 14th. inst., I have sent you under separate cover copy of the Official Proceedings of our Club for the month of February and enclose receipt for the 20 cents sent me for the same. Am glad to know that your are interested in our monthly Proceedings.

At the time your letter reached me in my office, Mr. Angus Sinclair had just called in for a couple copies of some back numbers of our Proceedings and believing that your letter would interest him, as it did me, I took the opportunity to show it to him. He read it with interest and made note of the contents, with particular reference to your age, with the intention I presume of making mention of it in the monthly magazine which he publishes.

It certainly must be very interesting to one, like yourself, who has been following railroad matters so long to note the advancement and progress made in the way of steel passenger and freight car equipment, heavier type of locomotives, improved shop facilities, etc., to say nothing of what the Federal and State laws require of railroads in the present age. With best wishes for your continued good health, I am

Respectfully,

J. B. ANDERSON,

Secretary.

MR. L. H. TURNER: Mr. President, I am greatly pleased to have an opportunity of saying a word in connection with Mr. Kirby, as he certainly is the "Grand Old Man" in the railroad

mechanical-department of this country. It has been my privilege to have known Mr. Kirby much longer than any gentleman in the room. At the time that I was heating rivets in the boiler shop at Adrian, Mich., in 1869, he was Master Car Builder at the same point for what is now the Lake Shoe & Michigan Southern Ry., but was then known as the Michigan Southern & Northern Indiana, and as most of you know that I should have been "Oslerized" some years ago, you can readily understand that my acquaintance with Mr. Kirby has been over forty-five years duration.

During this time, I have had the privilege of transacting a great deal of business with Master Car Builders all over the United States, and while as a class, they are high-minded, honorable gentlemen, John Kirby was the peer of them all, and nothing with a suspicion of sharp practice was ever indulged in or permitted by him, and I am glad that this Club takes the time to pay tribute to a man whom we can all emulate with profit.

MR. F. H. STARK: Mr. President, The communication from Mr. Kirby is of more than ordinary interest to me for it was under his jurisdiction that I first commenced railroad service.

As a subordinate, I recognize his executive ability and his ideal administrative policy. He was a close observer of men, always recognizing and rewarding merit. In his official dealings he was uniformily fair, requesting of others only that which he was willing to grant and yet securing for his company what was due.

In later years he was frequently referred to as "Uncle John" or "Honest John" an honorable distinction acquired during a long and very active life. He was a man of natural and self-acquired wisdom and ability. In the early days he personally made practically all of the working drawings and estimate of cost of equipment. His original ideas worked out in practice, for it is a well known fact that Lake Shore freight equipment gave unexcelled service, considered from a point of proportion of load to tare weight of car together with the cost of maintenance. He was far in advance of his time in many respects. He introduced freight cars with metal plates covering the superstructure both exterior and interior and were built during the Civil War for the transportation of explosive.

He introduced metal truck bolsters in the early seventies, which in principle and design are practically the same design as the Simplex and other modern bolsters.

There are many details of car construction inaugurated by Mr. Kirby that have proven to be the survival of the fittest. In some cases many departed only to return to Mr. Kirby's original ideas or principle. I have frequently taken advantage of the opportunity of consulting Mr. Kirby on important mechanical matters with the highest regard for his judgment.

His name will be linked and associated with that of Van Houten, Adams, Andrews, Gerry, Verbyck, McWood and other pioneer car builders. It is very fitting that we pay homeage to the living, more especially to those who have contributed so largely to the progress of this country.

Mr. Kirby is now 90 years old, God giving him mental and physical strength so that at his advanced age he is still vitally interested in every phase of human activity and may the sunset of his life abound in sweet fruition as a merited reward.

PRESIDENT: I know we are all pleased to hear this complimentary communication from Mr. Kirby and the remarks of our members in connection with the same.

PRESIDENT: Gentlemen, we are especially fortunate tonight in that we are to be addressed by Mr. Walter V. Turner, Chief Engineer, Westinghouse Air Brake Company, who will speak to us on the subject "Braking Power" its interpretation and its application with particular reference to Passenger service.

"BRAKING POWER"—ITS INTERPRETATION AND ITS APPLICATION. WITH PARTICULAR REFERENCE TO PASSENGER SERVICE

By Walter V. Turner,
Chief Engineer, Westinghouse Air Brake Company.

Mr. President and Fellow-Members:

The subject and substance of the paper which I have the privilege of presenting to you this evening concerns a very obtuse and apparently but little understood phase of the science of brak-

ing. Nor do I pretend that I fully comprehend all its essentials or its details, but I do believe that my study of the subject and the experience I have had in the past few years have enabled me to reduce the underlying principles, both as to the braking force permissible to develop and what must be embodied in a foundation brake gear design, to a scientific basis never before attained, or at least recorded.

It would take considerable time to go into the reasons why I first gave this subject such serious thought, for like a good many of my friends, I supposed that about nine-tenths of the effectiveness of the air brake was in the performance of the air actuated devices and about one-tenth in the effectiveness, or the efficiency, of the foundation brake gear; or, at least, one design was as good as another; or, again, to put it still another way, I thought but little of the matter, but I have since discovered that this ratio might well be reversed, for without an efficient and properly designed foundation brake gear, the very highest developed and most efficient air brake mechanism is of little value; in fact, in my judgment, it is better to use inferior and less powerful air brake valve mechanisms with poorly designed and improperly proportioned volumes and braking ratios than to use efficient brake mechanisms in such cases.

The brake which can transform the fluid pressure of compressed air into a very great mechanical force needs a foundation gear adequate for the development of this force, and, if it is not provided, distortions, shifting of wheel weights, unequal division of the force to the wheels, binding of the wheels in the pedestals, in fact, every conceivable, undesirable condition in braking may occur to the loss and inconvenience of the road and to the retardation in development of one of the principal things that has made the present scope of railroading possible, namely, the air brake. Of course, most of the ill effects of an improper understanding of the braking ratio problem and of inadequate and damaging designs of foundation brake gear are not apparent in themselves; that is to say, the foundation brake gear is a dormant appendage until the air actuated mechanism per se causes it to come into action, and since whatever damage or ill effects result, prima facie, must have been caused by the air valve itself inasmuch as everything was lovely until it was called upon to perform. One might as well blame a train for being

wrecked by a broken rail, for, obviously, the broken rail would not have mattered if the train had not come along; or blame the blowing up of a boiler on the steam that caused it, since, obviously, the boiler could not have blown up had there been no steam present, but, in this case, most men of sense blame it either upon improper design or maintenance of the boiler, and I have hope that some day the same line of reasoning will be applied to the two interdependent and intimately related parts of the air brake, namely, the air actuated devices and the foundation brake gear through which is transformed the air pressure into a mechanical force and then transmitted through the shoe to the wheel.

Suppose, for example, one should design and build a locomotive capable of transmitting 40,000 pounds to the drivers and then provide connecting rods capable of properly and effectively transmitting but 30,000 pounds. What would be the result on the one hand, and what our opinion of the designer on the other?

I had gone through several so-called air brake tests and had studied considerable literature on the subject before the commencement of the air brake tests at Toledo in 1909, and I believe you will pardon me for saying that I had made something of an analysis of the braking situation and potential, the working out concretely of which has resulted in some very desirable and profitable improvements. But at Toledo and subsequently in the installation of air brake mechanisms capable of developing great forces, it was apparent that the foundation brake gear was very inefficient in transmitting the air pressure to the shoe on the one hand; and that due to distortions, binding of wheels, forming of toggle joints, and turning the truck frame into a suspension beam for the wheels, very unequal braking force producing surges and wheel sliding, could occur, on the other.

At these tests, we had every reason, based upon the state of the art at that time, to believe that with the air brake mechanism recently designed a stop could be made, with the braking ratio to be employed, in 1200 feet, but somewhat to our surprise, it required something like 250 feet more than this, and I can well remember pondering over the causes for several days and among the five causes which I finally concluded were

the reason of this, I found the one of improper and inefficient design of foundation brake gear—the other four being

(1) greater loss than anticipated in coefficient of the brake shoe, due to the higher forces developed,

(2) the greater mass of locomotive which was unbraked,

(3) the larger brake cylinder volume without proportional provision for getting the air into the brake cylinder quickly,

(4) increased length of time in which to get the brakes started throughout the train, due to longer cars, which means greater brake pipe volume to be exhausted without adequate provision being made in increased number or efficiency of quick action venting devices for the purpose.

All of these five causes were written down in my note book at the time and were copied therefrom today, and I know you will pardon the strong sense of gratification which I feel in the knowledge we now have that each one of these was thoroughly investigated in our recent experiments in brake testing at Atlantic City and every one abundantly confirmed. In fact, a modification of any one of these factors in any considerable degree evidenced itself by such a wide margin as to be indisputable. It is because of this, that what is to follow speaks forth with such assurance, and I have no hesitation in saying with *a period* at the end of the statement; that any violation of the principles laid down will result in inefficiency and loss.

I can imagine some people saying that it will cost considerable money to properly construct trucks and foundation brake gear to do what you are asking, to say nothing of many changes on equipment already existing. This I grant, but it costs money to do anything and when money is advisedly and intelligently spent, as it would be in this case, the returns much more than compensate for the expenditure. In fact, this is the basis of all business and, thank God, in spite of the demagogue and the pessimist we still have a few men with us who are big enough and broad enough to see that progress can only be made by spending money to develop and utilize exceptional ability in any direction, thus capitalizing that wonderful attribute of the

human being which sees that the height already obtained is but a stepping stone to a still higher plane.

Among the smallest influences of progress and development are those people who do not possess a proper sense of proportion between the great and small. They strain at a gnat and swallow a camel, and become so blinded by the mote in their eye that they do not see the wonderful possibilities and gain, in all senses, in that great beam of propulsion in any improvement which, figuratively speaking, makes two blades of grass grow where one grew before. This is, however, a fraility of human nature in many respects, for a man is concerned only with that which immediately concerns him, and if his particular duty is concerned with keeping down troubles, or short-comings, or worries, he is apt to magnify these, losing sight entirely of the greater gain and benefit, and with one full swipe he would make these impossible by eliminating that, which he supposed caused them, without the slighest compulsion or consideration that in doing so it would carry with it the very benefits and advancement for which the improvement was made. And bear in mind only too often it is what *he imagines* to be the cause (which may, in fact, be only the prime mover) the real cause of the trouble *being* that which comes in between this cause and the result. This is what is usually called the line of least resistance, and I doubt if there is any expression in the English language which is more truly expressive; certainly there is *none* which more surely determines the state in which the advocate will continue to exist, namely, a hewer of wood and a drawer of water, even if it does not sooner or later end in sinking into a state closely approaching innocuous desuetude.

I do not intend here to advance any cause by special pleading, or to assume that all complaints or opposition are invalid or unjustified, but I do most emphatically advocate and insist that the complaints be valid and justified, and to be this, they must be directed against that which is at fault and substantial evidence advanced in support of the position taken. Assertion, as such, has no validity to him who does not accept it, but a fact is stronger than the strongest intellect and no man entrusted with supervising the great development of our railroads should accept unsupported assertions as conclusive evidence of good or bad of those things which go to make up the wonderful

mechanism of this great factor of civilization. Right here I presume to offer a word of advice to you gentlemen whose duty it is to pass upon reports and information regarding the equipments on your railroads, and *this is to generally* take an assertion of failure or trouble of a particular unit of the apparatus employed by you *as proving the contrary* to what is often tacked on to the assertion, namely, that the apparatus is *no* good, or detrimental. In most cases you will find that this fault, or failing, is an exception to the general performance of the device, or apparatus and, therefore, that in the main, the performance is all that was promised or to be expected. In other words, on occasional failure only proves that, in general, things are as they should be; while the failures mentioned may, if run down, be found chargeable to circumstances over which the designer had no control, and whose existence need not exist if its effect on is all that was promised or to be expected. In other words, an *not sufficient to make a man see double.* What I am trying to get at is that troubles and short-comings, inconveniences, and ups and downs, have existed since the coming into existence of railroads, and it is fortunate for all of us here that this is so, for if the bringing into existence of any thing brought with it the property of being automatic as to desired results, there would be little use for most of us.

The easiest way to eliminate any trouble or inconvenience is to eliminate its cause, whatever the primary reason for its existence may be, no matter what virtues go with it. He who kills the goose that lays the golden egg will not be troubled thereafter by the care of the goose; neither will he be troubled *by the possession of golden eggs.* Some of the people, however, to whom we owe our present state of civilization and progress, do not believe in killing the goose. They would rather remove to the greatest practical degree the abuses which produce the trouble, or, failing this, discount the troubles for the reason that the benefits realized vastly more than compensate for the undesirable and detrimental things that must to more or less degree accompany anything, no matter how good it may be. It is because of the fact that in brake and foundation gear design, we have the source of many of the troubles, and much of the inefficiency of air brakes, that I attempt this analysis tonight.

As I have found fault myself with the composition, or man-

ner in which this paper is written, I feel I must beg your indulgence in this respect at least for tonight. I have particular reference to some looseness of expression and connection, but to have avoided this would have taken more time than I had at my disposal, and would probably so lengthen the paper as would have more severely tried your patience than I fear I shall even now do.

In a discussion of the subject of braking "power" we are hampered at the outset with the same difficulty that has been the case, and still is, with many problems in air brake engineering: that is, the absence of a hitching-post or standard criterion and by the general vagueness and ambiguity of our engineering terms. This may be due to the fact that up to a few years ago, the air brake business was simply a business and not an engineering or scientific development. It was largely a question of rule of thumb, or cut and try, and such methods are not conducive to standards. In the past few years, however, the development has been very largely along strictly engineering or scientific lines, and many of our problems have been reduced to an engineering or scientific basis, but still there are some with which it is not the case, and this "braking power" question is one of them.

Definitions of Braking Power.

When one attempts to consider this question, he is confronted at the outset by the realization that "per cent braking power" by itself is vague, indefinite, and ambiguous, for unless the context clearly brings out the intended meaning, "per cent braking power" may mean the ratio of the shoe pressure to the weight of the car, and this either for service or emergency, or both, or it may be intended to mean the ratio of the retarding force to the weight of the car, and this again can be for either service or emergency, or both. Still, again, it may mean the former of the preceding less certain assumed losses of brake rigging, etc. Again, "per cent braking power" and "braking power" are often used synonymously, although the latter, strictly speaking, applies only to shoe pressure, that is, total cylinder pressure times the leverage ratio, which does not necessarily have any fixed relation to the weight of the car, while "per cent braking power" does. Thus it will be seen that in using this

expression, one must be careful to state the extent in which it is to be taken by surrounding it with a context sufficiently explanatory to clearly define and limit the speaker's meaning.

It will be observed that the writer is starting out by drawing distinctions and it is his intention to do so all the way through this discussion, for the prevailing misunderstandings and improper installations are due either to not knowing or not observing these distinctions. In a general way most of what the writer has to say is quite well known in the braking art; for instance, possibly all the terms are quite familiar, in fact, so familiar that I often hear them expressed readily and easily in a discourse, first in one sense and then another and with little apparent difficulty in making at least some of them fit the condition whatever it may be, while gracefully ignoring the rest, and it is to avoid this and to try to correlate and connect the whole that is the writer's endeavor. Hence, the necessity for observing the close distinctions, interrelation and interdependence of one thing upon another which is shown here. This subject cannot be considered in part. It must be taken as a whole, or chaos in some degree is the result.

Braking Power and Braking Ratio.

It would seem when considering a brake installation that the term "braking power" or braking ratio, might properly be employed. Preferably braking ratio, because "braking power" is a misnomer, since power is the rate of doing work which is not even a factor in the case we are now considering, and since even when applied to the stopping of a train, no fixed relation exists between the "braking power" and the length of stop. If employed when considering brake performance, it can only be in an arbitrary sense, which is inexcusable if a precise and fundamental term can be employed.

"Braking power" is nothing but air brake parlance, for it has no scientific basis and is not a convertible term, and, except the user consciously or unconsciously translates the expression, it has no practical value. In the writer's judgement, it is not a sufficient justification for its use to say that its various usages are understood by air brake engineers, for we are not concerned about convincing them as to the utility and degree of earning power inherent in a brake, but the layman to whom, if we are

to convince and persuade, we must employ terms which naturally he understands, from the fact that they are not arbitrary.

That is, inasmuch as "braking power" and retarding force have no fixed relation to each other, when speaking of dissipating the energy in a moving train, the term "braking power" is ambiguous, since the actual ratio of shoe pressure to the weight of the car per se gives but little information as to the actual length of stop, so it would seem that the term which should be employed in such cases should indicate the retaring force, by this meaning the stopping force actually realized and not the nominal shoe pressure of the installation. In fact, such a term is now used in brake test analysis, for the factor of retardation is the ratio between the average actual stopping force realized and the weight of the car.

Braking Ratio and Factor of Retardation.

The confusion arising from assuming braking ratio and factor of retardation to mean the same thing, makes it desirable that the terms should be clearly defined, and then it will be seen that the former is better adapted for use when considering brake installations, and the latter, as the criterion of brake performance. This will be all the more apparent when it is remembered that uniformity of stopping distances cannot be assured for any given car, even though the levers, cylinder, etc., are of the generally accepted proportions, by arbitrarily prescribing any braking ratio, unless three other factors can be known and insured, namely, time to get the required cylinder pressure, the efficiency of the brake rigging, and the coefficient of friction of the brake shoe. With these three things known, the percentage of so-called "braking power," but more properly braking ratio, which must be used to produce a given stop from a given speed, can be determined.

In general practice, however, it is practically impossible to know these factors when contemplating a brake installation, therefore, nothing more than an arbitrary percentage can be determined upon. This, then, is as far as one can go when considering what percentage of "braking power" shall be employed for general service, or as we may say, arbitrarily determined upon in order to have a working basis.

Standard Braking Ratio for Passenger Service.

It is obvious that a number of things may have to be taken into account in fixing what this base shall be. For example, among the many things we have to consider in choosing the percentage or ratio for service operation is one, which at present should be the determining consideration, namely, that a ratio of 90 per cent is commonly accepted. This 90 per cent for service braking is predicated upon at least 90 pound brake pipe pressure being carried—a higher pressure than this being only necessary in order to obtain a braking ratio in emergency applications. If less than 90 pounds is carried, it is self-evident that less than 90 per cent for a full service application (the term service application now being used in the sense of equalization, while the term full service application upon which the 90 per cent is predicated is with reference to the maximum service braking power permissible in service control of trains; that is to say, the maximum that permits of a flexible brake with reasonable freedom from shocks, wheel sliding, etc.) will result and must be tolerated for the reason that uniformity in interchange of cars either on the same road or with other roads would not be practicable, for, obviously, it is the per cent on the highest cylinder pressure that must control where interchange is a consideration and in general to base the maximum braking ratio upon a low cylinder pressure (say, lower than 60 pounds) would result in a rough brake.

(For the sake of uniformity of installation and consequent operation this 90 per cent should be obtained with a reduction of 24 pounds in the auxiliary reservoir.)

The reason the expression is not made to read "90 per cent braking ratio *for a full service application*" is because the *underlined* part of it is superfluous—since it is above stated that 90 per cent braking ratio is a "full service application," for this is the meaning of 90 per cent as the maximum service braking ratio. Also, to many "full service application" means the equalizing point of the auxiliary and brake cylinder, which has *no* value in present day practice as it is so variable, being 50 pounds, if 70 pounds brake pipe pressure is carried and the auxiliary reservoir and brake cylinder are of proper proportion, and 60 pounds if 90 pounds brake pipe pressure is carried. Also 60 pounds if 110 pounds brake pipe pressure is carried and a

reducing or limiting valve used on the brake cylinder; and, again, 86 pounds if the PC equipment is used and 110 pounds brake pipe pressure carried. It is not here submitted that 90 per cent is the best ratio, only that at present there are many more reasons for its retention than there are for an endeavor to change it. If this be granted, then we are concerned only with the phraseology by which it will be expressed.

Now the phraseology includes an expression of cylinder pressure, for example, "90 per cent braking power on 60 pounds cylinder pressure" and so on, and in this dissertation it is set forth how ill-chosen, vague, and confusing this expression is, *for it gives more information than is required when one is concerned only with the question of what ratio shoe pressure should bear to the weight of the car, and far less than what it should give when one is concerned with an actual brake installation,* no matter whether this brake installation is being made to produce a specified rate of retardation, or is merely to equip a car with a brake.

How ridiculous the term 90 per cent braking ratio for a full service application (meaning by this, the equalizing point of auxiliary reservoir and brake cylinder) is, will be seen, when to one man this is 50 pounds cylinder pressure; another 60; another 86, and so on, either and all being full service applications in their understanding of the term. Suppose now that the cars so designed for the 90 per cent were placed in the same train and 90 pounds brake pipe pressure carried, the full service braking ratio on the first mentioned would be 110 per cent; the second 90 per cent; on the third it would be 70 per cent. (Quite a conglomeration of braking ratios.) Contrast this with the term 90 per cent for maxium service braking ratio, predicated upon the cylinder pressure obtained from a fall of 24 pounds in the auxiliary reservoir. From this absolute uniformity of braking ratio must result in a train *no matter what the actual cylinder pressure may be.*

This should make clear that the term "full service braking power" has no more precise meaning than has the term "60 pounds cylinder pressure," since neither is limited to one meaning or interpretation, while no one can get more than one meaning out of the expression, 90 per cent as the maximum braking ratio of the service brake.

When once it is understood that the 90 per cent braking ratio has been determined upon as the maximum permissible (for reasons stated elsewhere) for "station stop" brake performance; and, when reaching the necessity for working this out for concrete application, that 24 pounds reduction in auxiliary reservoir pressure is fixed upon as the most desirable quantity from which to realize it (this also for reasons stated elsewhere); the confusion arising from mixing maximum service braking ratio and equalization between auxiliary reservoir and brake cylinder will disappear. Both have been termed loosely full service brake applications but do not necessarily have any connection with each other, as the latter, for instance, may result when only 50 pounds cylinder pressure is obtained, which may not give anything near the 90 per cent braking ratio. In other words, in one case, one deals with braking ratio per se and in the other with cylinder pressure per se and the quantity, that is, value, of the latter, has nothing to do with what braking ratio is best or permissible for "service" braking. In speaking of braking ratio for service work I am not talking of "all a man can get" but of what he should get and how it should be got to have a brake of maximum efficiency, all things considered.

The other controllable element as stated above that enters into the primary factors of uniformity in braking effect is that of time; that is to say, the time to make the 24 pounds reduction, and the time to realize 90 per cent braking ratio should be predetermined and long enough to insure such a sufficiently slow development of the braking ratio as will avoid severe bunching of the train, which, due to a more rapid rate of fall at the front of the train, would occur if not provided against. It has been found that if the 90 per cent braking ratio is realized with a 24 pound reduction in 7 seconds, all the smoothness of operation necessary is obtained. Therefore, 7 seconds should be the time fixed.

The 90 per cent braking ratio

The 24 lb. auxiliary reservoir reduction

The 7 seconds time in which to get this braking ratio given by the writer as requirements are generally accepted, or, if not accepted, are generally used in brake practice today; therefore, it is not the intention to start anything new or upset things, in these respects, but to get the whole matter down to

a precise and systemmatic statement and make known the reasons and establish a base for brake installations and foundation brake gear which shall be common to all. If the base here laid down is followed, uniformity of braking ratio is bound to result, as the quantity varies only as the brake pipe pressure varies, whereas if some one uses the equalizing point from, say, 70 pounds pressure as a base for 90 per cent braking ratio simply because this 90 per cent is recommended, the cars so braked will not operate harmoniously with others for which a higher auxiliary reservoir pressure was employed as a base from which to calculate the braking ratio.

The terms and method here recommended have the additional virtues of being the only ones that can be generally applied, that is to say, they will fit all equipments, whereas if cylinder pressure is employed one will have to keep constantly in mind that the cylinder base may vary for each equipment. For instance, if we say 90 per cent on 60 pounds cylinder pressure, for the PC it will be 60/86 of 90, and for an equipment where 50 pounds was realized, the statement would have to be 50/60 of 90, and so on. As it is self evident that the 90 per cent braking ratio, if brakes are to operate harmoniously in the same train all must obtain this 90 per cent at the same rate and for the same reduction, and this reduction by a practically unanimous consent is 24 pounds, it would seem that there is not even room for debate as to the advisability from an engineering standpoint of using the expression that covers all cases, namely, 90 per cent realized from a reduction of 24 pounds in the auxiliary reservoir pressure. Of course, it is understood that no matter in what round about way the 90 per cent braking ratio is expressed that it finally comes back to what is here proposed; and, therefore, the expression advocated does not change the values of any of the terms or any conditions, simply wipes out a little of the useless verbiage and therefore simplifies the whole proposition to all those whom habit has not enslaved or who are new to the discussion.

Two Phases of Problem.

To permit of an intelligent understanding and application of what is involved in the term "braking power," we are compelled to divide it into two divisions—one dealing strictly with

brake designs and installations, and the other only with the stopping of trains, since the former involves only determinate factors, while the latter involves extremely variable phenomena which can only be compensated for in any measure by varying the nominal braking ratio proportionately to the losses to be expected in any particular installation.

Retardation Phase.

The factors always involved in the consideration of the latter, or retardation phase of the question are: the time in which the cylinder pressure is obtained, the ultimate and continuous pressure realized, the efficiency of the foundation brake rigging, and the coefficient of the brake shoe, that is to say, the mean coefficient of friction realized throughout the stop. Obviously, the brake apparatus which realizes the highest cylinder pressure in the shortest time and is the most uniform in its action, is the best brake apparatus, and as there is an apparatus which fulfills all present requirements in this respect, it may be said that this is a fixed quantity—that foundation brake gear having the highest efficiency, other things being equal, is the best foundation brake gear, and as this is purely a matter of design, this may also with reason be pronounced a fixed quantity; all the more so since we have designs in which the output is almost equal to the input. In the brake shoe we are confronted with the extreme problem as regards securing uniformity of retarding force, for the performance of this element of the brake apparatus is extremely variable, it having a range of over 300 per cent according to conditions and circumstances. The performances of the shoe depends essentially upon its temperature; its effectiveness increasing with the temperature up to the critical point and then decreasing until the molten point is reached (which is as far as we need to consider here), or until such rapid abrasion takes place as to virtually present a fresh contact surface which prevents the temperature rising further as would otherwise be the case. This temperature in turn depends upon three factors: (1) upon the pressure per square inch of the shoe area in actual contact; (2) the speed at which this area is being traversed by the other contacting factor (that is, the wheel), and (3) the time the rubbing surfaces (that is, the shoe and the wheel) are in contact. If this be true, then

the performance of the brake shoe is likewise affected by the three factors mentioned, not directly, but indirectly, that is, by the heat generated.

To prevent an apparent contradiction, of what has been stated in the preceding paragraph regarding the brake shoe, by a reference to some particular stop, the writer desires to state that all the factors mentioned are actually present in any train stop, but since some of them may be working in one direction and some in another, the actual effect may be a constant as far as the coefficient of friction is concerned. For example, the effect of time, unless neutralized, is to lower the coefficient of friction; the effect of reducing the speed, unless neutralized, is to increase the coefficient of friction; obviously, then, the net result may be an increasing, a decreasing, or a constant coefficient of friction throughout the stop, or all of these may occur at different times during a single stop.

The foregoing paragraph has been inserted because while the preliminary draft was being prepared, it was stated that the preceding paragraph was contradicted by actual test records. The reverse, however, is the case, and this will be clear after the reflection that a combination of factors may apparently contradict the presence of any or all that have produced the observed result. For instance, if the seven colors of the spectrum are mixed together, white will result, which on the face of it, contradicts the presence of red, or, in fact, any of the other colors, but they are there just the same, and he who deals with the subject of colors must take this into consideration just as the man who expects to employ his talents in brake design, has to have in mind all the phenomena involved in train braking.

From these considerations, namely, time, cylinder pressure, efficiency of brake rigging, performance of brake shoe, it follows, as above stated, that the nominal braking ratio of the installation has no fixed bearing upon the actual retarding force realized when it comes to stopping a train, that is to say, it gives no direct or conclusive information as to the length of stop.

Installation Phase.

When considering in a general way the installation of a

brake on a vehicle, it is necessary only to employ a ratio of brake shoe pressure to empty weight of car which engineering practice and experience have determined as most desirable and this either for service or emergency operation, or both. Whereas, when it is desired to make an installation in which a certain rate of retardation in miles per hour per second is desired, or in which a certain stopping distance is specified, it is essential that the other factors must all be known, or fixed upon, before the braking ratio per se is even considered.

Some may contend (which contention might be pertinent, viewed from a manufacturing standpoint) that we are only concerned with a recommendation as to what the braking ratio for a brake installation should be. There was some justification for this until a few years ago, but since that time, many cases have been entirely of the other class, as for instance, the Interborough, where the question was, how much time could be saved on their schedules—the New York Central, where the consideration was a 1200-foot stop—the Pennsylvania Railroad, where the most efficient brake was the consideration, service and all other factors being considered, and the New York Municipal Railway, where the actual rate of retardation in miles per hour per sec. on the loaded weight of the car, both in service and emergency and at different speeds, is specified. In fact, wherever the question of performance of brakes is concerned, as in brake tests, safe and efficient service, the cylinder pressure from which the braking ratio is obtained is the last thing to be considered, and the customary statements of "90 on 60, etc.," have little more application to the matter in hand than has the length of the smoke stack to the diameter of the drivers.

To better illustrate, let us take an example that may carry our minds away from that line of thought which is clouded by usage and customary thinking. Suppose we take the building of a car, first comes the thought of building the car, second, what its capacity shall be, and, third, the details of its construction; but to a different individual from the preceding, or if it be the same individual, he is acting in an entirely different capacity, other considerations enter, but primarily neither the other fellow nor himself starts out with the statement "a car of 70,000 pounds capacity with 5x9 axle." When the number and size of axles is determined upon, it must be along with

many other details, for alone this would give no more information than the mere mention of the capacity. Thus, when he thinks of equiping the car with a speed control system, the first thought is of that which is necessary so to control the car; the second thought is what ratio of brake shoe pressure to the weight of the car will best serve the purpose, all things considered, and the whole question rests right here until this is decided. After this is decided, comes the question of cylinder pressure and many other details, none of which could be omitted any more than the cylinder pressure and have any brake design left.

Sufficiency of An Expression of Braking Ratio.

Having, as we believe, established the case, viz., that we are confronted and concerned with two entirely separate and distinct phases of the braking problem, that is, the one where where it is simply a question of brake installation, and the other, where it is the much broader question of securing a specified or required retarding force; or more concretely one phase as viewed by the car designer and builder, the other by those concerned with efficient train braking, we may now state the logical and practical development of what has been said, namely, that until we actually reach the question of car design, we are concerned only with the ratio of the shoe pressure to the weight of the car. That is to say, because of the necessity for having a base from which to work for cases where retardation requirements are not given, we must fix on some arbitrary percentage, such as, 60 per cent for freight service, and 90 per cent for passenger service, or we would have no starting place when we come to a brake installation. Moreover, without such a base the result would be a hodge-podge of braking percentages. When retardation requirements have to be met, the braking ratio required must be left until other factors are determined upon.

With this proposition before us, it will be clearly seen that no matter which phase we are considering, the question of cylinder pressure, ratio of leverage, etc., does not enter until we come to the actual "lay out" for a brake installation, and thus it is unnecessary and confusing to point out any of the

other factors involved until they arise from the nature of the case.

It will not be sufficient to dismiss what this discussion is intended to bring about, namely, the question of using braking ratio without mention of cylinder pressure initially, by the statement that every one knows when the term cylinder pressure tacked on to "braking power" means anything and when it does not. This is simply begging the question since the writer contends (1st) that everybody does not know, (2nd) that those who do, often use it and confuse those who do not, and (3rd) that to couple indiscriminately the two terms together is unscientific and exhibits a looseness of conception with consequent neglect of principles which has no place in engineering practice.

From these considerations, the writer would suggest that in the future recommendations should be for some arbitrary per cent braking ratio for both service and emergency operations without any reference whatever to the cylinder pressure from which it is to be realized—this question of cylinder pressure only to come into the statement when we can no longer proceed without it, which, obviously, is when we are considering some specified brake installation. The recommendation I would suggest to be 90 per cent braking ratio for service and 150 per cent for emergency, it being understood, of course, that all information required by those concerned with brake installations will be supplied in specifications for their use.

Independence of Braking Ratio and Cylinder Pressure.

That the writer's position may be properly understood and the value of the suggestion appreciated, he considers it desirable to add the following matter, as it reduces the foregoing to a concrete engineering basis.

First: That braking ratio per se has nothing whatever to do with cylinder pressure. This will be more clearly realized when it is considered that braking ratio is nothing but a ratio and that neither of the terms in the ratio is cylinder pressure—one of the terms being shoe pressure, the other the weight of the car.

Second: That neither braking ratio nor cylinder pressure bears any fixed relation to the retarding force developed.

THIRD: That to couple braking ratio and cylinder pressure together, unless actually laying out a brake installation, is confusing and misleading.

FOURTH: That primarily when speaking of the force necessary to control a train, or what braking ratio it would be best to employ, the cylinder pressure is not a factor, but is merely one of the many details that later come into the matter. For instance, when kind of brake apparatus, existing practice, or car design, becomes the subject for consideration.

FIFTH: That cylinder pressures for the service operations of the brake are now so numerous that if cylinder pressure is mentioned at all, all of them must be mentioned, or the particular equipment for which one is speaking must be specified and the discussion limited to this particular one.

SIXTH: That if it is considered necessary to tack the brake cylinder pressure to braking ratio whenever this is mentioned, as is very generally done, no matter whether speaking of train control or brake installation, why not also mention the ratio of leverage to be employed; the ultimate pressure that will be obtained in emergency applications, since this is necessary before the lever designs can be made, the stresses permissible in levers and rods, the piston travel required to give proper shoe clearance; and any other details that are as essential to the brake question as is that of cylinder pressure.

All of these are essential factors at a certain stage of the consideration, but none of them need to be mentioned to assist in the discussion of what braking ratio should be employed, and since not needed must necessarily make the discussion more complex and unintelligible. This may not appear so to the man long accustomed to using "90 per cent braking power on 60 pounds cylinder pressure" in the same sense as he would use a symbol, or who thinks of it as he would a single term, either of which make it mean something different to him from what it may mean to another, but the writer has found by tedious experience that if he can keep the two separated when discussing brake phenomena, such as wheel sliding, long and short stops, etc., that much more rapid headway can be made to a clearer and more intelligent comprehension that 90 per cent

braking ratio is 90 per cent braking ratio irrespective of the cylinder pressure, and is also able to dodge the most terrifying question he now has to frequently answer, namely, "Why is it that 86 pounds cylinder pressure will not slide more wheels than 60?"

From the foregoing, it will be seen that as far as train control is concerned, we are (1st) concerned with the braking ratio required, desired, or permissible, and (2nd) with all the factors required to obtain the braking ratio determined upon, in which among many other things brake cylinder pressure is involved.

It is evident then that braking ratio is independent of cylinder pressure and consequently the expression is made confusing by mention of cylinder pressure until required and may even be harmful, as is evidenced by the fact that some recommendations as they stand (calling for 90 on 60, 80 on 60, etc.) prohibit the employment of the PC equipment, since it obtains only about 63 per cent braking ratio on 60 pounds cylinder pressure although its maximum service braking ratio is, of course, 90 per cent.

The suggestion that we leave off the expression of cylinder pressure when speaking of braking ratio clears the question of all confusion; while fixing on some specific figure gives this ratio a definite value and affords a working basis, or starting point, for general brake installations, but even this only affords a means for discussing in a general way the question of braking ratio, its chief merit in this connection being that it is free from the term which misleads, misleading because it must give the impression either that cylinder pressure is indispensable to the expression of braking ratio, or, that by its statement the expression is made full and complete, or both these, whereas, as a matter of fact, in neither case is it so.

Proposed Standard Recommendation.

With regard to the suggestion that 90 per cent braking ratio, obtained by a 24 pound reduction in the auxiliary reservoir pressure, be recommended as the most logical I may say that it is not the writer's intention to inquire fully into the question of whether or not the long used and generally accepted 90 per cent braking ratio for service applications is either the scientific

percentage or the best practicable percentage. Personally, he believes this to be the case and can furnish very good evidence that this is so, but whether so or not, it would be a very hard task in the first place to change it, and, in the second, the supplanting percentage would have to demonstrate marked superiority before it would be considered worth while to make the attempt to change, and, certainly, before it would be accepted. This is supposing that the change would be great. If it would not be so, it certainly does not deserve consideration.

Briefly, my reasons for suggesting that 90 per cent braking ratio be recommended as the standard are:

> FIRST: 90 per cent has been a common standard for years and, therefore, requires that sufficient reasons be advanced to justify a change and the writer knows none.
>
> SECOND: This percentage braking ratio happens to be the critical point for the installation of new apparatus and any recommendation which calls for higher than 90 per cent braking ratio for a full service brake application would be open to the charge of requiring increased expense and troubles which appear prohibitive.
>
> THIRD: By keeping the braking power down to 90 per cent for a full service brake application, it is possible to obtain a safe and satisfactory margin between maximum service and maximum emergency braking ratio.

If the foregoing is accepted as correct reasoning, we have then reached a starting point in the endeavor to accomplish the purpose as expressed above, namely, that 90 per cent braking ratio be declared as the standard maximum braking ratio for service applications. If this be accepted, then the writer would suggest that, with a pneumatic brake, this 90 per cent be obtained by the reduction of 24 pounds pressure in the auxiliary reservoir. This reduction to be caused by a flow of air at an approximately uniform rate from the auxiliary reservoir to the brake cylinder, this rate to be such that the time of obtaining it is 7 seconds.

These three requirements cover all with which we are concerned in the design and installation of the air valves. From these we may go on to the leverage ratio that should be considered standard and the cylinder pressure upon which this per-

centage of braking ratio should be based, but these are derived factors and not fundamental factors, since the leverage ratio permissible is determined by the car and truck construction and by the kind of foundation brake rigging employed; while the cylinder pressure upon which the 90 per cent braking ratio must be based is determined by various other considerations, such as, type of brake equipment, class of service, etc. Please observe that the writer is not concerned with any specified set of figures, for he is willing to accept any change in these that shall be shown to have greater warrant than those submitted. What he is concerned with is the adoption of some criterion or standard that will prevent many of the present vagaries and conflicting propensities. In other words, he desires that we may be able to say "that after due deliberation and consideration of all the interests, conditions, and other considerations, such and such a standard has been adopted and before you, whoever it may be, can hope for the acceptance of what you propose you must attack the standard and demonstrate that it can be obsoleted and conditions improved by the acceptance of your proposition."

Assuming now that 90 per cent braking ratio is accepted as the standard for service brake operations, the solution of the braking ratio problem for emergency applications is simple and *must* proceed along certain definite, and not to be varied from, lines, for *only* two avenues are open for its accomplishment, namely, (1st) by an increase in cylinder pressure and (2nd) by an increase in brake piston area. The method by an increase in brake cylinder volume is susceptible of accomplishment in two different ways—(1) by increasing the auxiliary reservoir pressure until at equalization with the brake cylinder the desired emergency braking ratio be obtained, and (2) by an increase in stored volume to such a degree that at its equalization into the brake cylinder the pressure required to give the emergency braking ratio will be obtained. As a corollary from these two, it is evident that it may be advisable in some cases and necessary in others that both of them be employed.

With regard to the second, namely, increase of brake piston area, it is plain that to increase the piston area by an increase in the diameter of a single piston would change the service standards of ratio and time, and therefore, this is manifestly not a permissible method. We are reduced to the necessity of

using an additional brake cylinder of such area, pressure considered, that the desired emergency braking ratio will be obtained.

The conclusion from these statements is that 90 per cent braking ratio obtained from 24 pounds reduction of auxiliary reservoir pressure once being accepted, the means and method of obtaining the emergency braking ratio is *absolutely* fixed. Reflection will also show that the quantity of emergency braking ratio may be unlimited, if it be obtained, by an increase of auxiliary reservoir pressure. The practical limit is determined by what brake pipe pressure may be carried. For instance, if the 90 per cent braking ratio was based upon 60 pounds cylinder pressure and the 60 pounds cylinder pressure was obtained by a 24-pound reduction, it is plain that the pressure carried was 84 pounds, assuming that the 24 pounds reduction produced equalization of auxiliary and brake cylinder pressures. Therefore, if it was desired to obtain 180 per cent braking ratio in emergency, it would be necessary to carry an auxiliary reservoir pressure of 168 pounds, equalization again being obtained. If the increase of emergency braking ratio is to be obtained by an increase of reservoir volume, (called supplementary reservoir) it is likewise plain that 150 per cent ratio is the limit that could be obtained in emergency, for the reason that from 110 pounds reservoir pressure carried, 100 pounds brake cylinder pressure is as high an equalization in the brake cylinder as other requirements, such as ability to release the brake, practical volume permissible, etc., will permit.

If the second method, namely, increase of piston area, is followed, again an unlimited value in braking ratio is possible, since the area of the emergency brake piston as compared with the service brake piston, may be of any ratio, requiring only that the necessary pressure or volume be carried to give the desired cylinder pressure.

Pages 176, 177 and 178 summarize the reasons why cylinder pressure is not necessary to the expression braking ratio; pages 178 and 179 summarize the reasons for choosing as a standard base the ratio suggested, while pages 180 and 181 state the means and method by which it is possible to obtain the emergency braking ratio; the quantity determining which method is best.

The following pages are intended to show, by an analysis,

the steps and factors necessary to an actual, "lay out" of a brake installation, and thus demonstrate the folly and inadequacy of adding to braking ratio the *single* factor *brake cylinder pressure,* when so many others are required to make a complete statement. That is, the expression braking ratio pure and simple serves every purpose until confronted with an actual "lay out."

Steps in a Brake "Lay Out."

At the outset we must decide the basis upon which the "lay out" must rest; that is, *whether it is to be from some arbitrarily chosen braking ratio, in which case the retardation may be what it will,* or *from some specified retardation, in which case the braking ratio can only be determined after many other factors are known.*

Lay Out With Arbitrarily Chosen Braking Ratio.

Dividing then the subject into these two problems, and considering first THE ONE STARTING WITH AN ARBITRARILY CHOSEN BRAKING RATIO, we would particularly call attention here to the fact that when some values are decided upon or chosen, others, with which many people seem to think they can play shuttlecock and battledore, must necessarily follow if we are to have a consistent whole. Commencing with (a) a car of known weight, (b) the braking ratio to be employed, it is next necessary to fix upon values, for (c) the range of flexibility, that is, the decrease in auxiliary reservoir pressure to be permitted before the braking ratio is realized, (d) shoe clearance, (e) brake piston travel, (f) the cylinder pressure from which the braking ratio is to be obtained, (g) the fiber stresses to be permitted, and (h) if the "emergency" braking ratio is to be greater than that for "service," this must be stated in quantity. These are thought to be all of the necessary factors or absolute values involved in a brake "lay out" where the braking ratio is specified, but there are certain other values which we must know; for instance, (i) the pressure that must be carried, (j) the auxiliary reservoir volume required, (k) the leverage ratio, (l) the size of the brake cylinder, (m) the size of the brake levers, etc. But these are all contingent factors, or derived values, and must be obtained from the others.

In other words, they cannot be arbitrarily determined, or fixed upon as can all of the preceding fundamental elements. To specify them without deriving them, would be an unwise risk, as the result would probably be the expression of contradictory or inconsistent values, and we submit the following (which makes evident how the derived values are secured from the fundamental values) in proof of this.

The car weight times the braking ratio specified gives the total shoe pressure.

The piston travel divided by the shoe clearance gives the leverage ratio.

The total shoe pressure divided by the leverage ratio will give the total cylinder pressure required.

The total cylinder pressure divided by the unit cylinder pressure will give the area of the piston, which fixes the size of the cylinder.

The volume of the cylinder multiplied by the unit cylinder pressure and divided by the range of flexibility will give the volume of the auxiliary reservoir and this fixes the size of the auxiliary reservoir.

The unit cylinder pressure plus the range of flexibility will give the necessary auxiliary reservoir pressure which fixes the brake pipe pressure to be carried.

The total cylinder pressure with the total shoe pressure and fiber stresses to be permitted gives all the necessary information that is required to design the foundation brake gear, the particular form which this shall take depending upon car and truck design and the designer's preference. (It is my personal judgement however, that only a "clasp brake gear" should be employed for modern heavy cars. I have had one or two experiences where the very best air brake mechanism was made very ineffective by an inefficient brake gear).

If the brake is a duplicate brake, that is, having a service braking ratio and an emergency braking ratio, the size or strength of the foundation brake gear must be based upon the maximum total cylinder pressure.

IT WILL BE SEEN THAT NOT ONE OF THESE EIGHT VALUES CAN BE INCLUDED AMONG WHAT

WE HAVE CALLED THE FUNDAMENTAL ELEMENTS, AND FURTHER, AND EVEN MORE IMPORTANT, NOT ONE OF THEM CAN BE ARBITRARILY CHOSEN, but must follow in the same manner that four follows the adding of two and two if we are to have a harmonious and consistent brake, and to avoid this being dismissed with the assertion that the ideal is not attainable, I will state that by harmonious and consistent, I mean a practical brake.

Choosing Arbitrary Values.

All the inconsistencies that exists in brake design and installation today are due to the non-obervance of these relationships, that is, one or more has been changed without changing the whole, and this cannot be done if the design is to contain but one set of physical dimensions. Remember the assertion is made that it cannot be done if a practical brake is to be had —the answer will be, that it is done. This, we admit, but with chaos and controversy as the inevitable result. Then follows the next statement of, I don't know, things are not so bad, and certainly better than if we had no brake at all. Admitted again, but with the question why is it as bad as it is, when it is far easier and much more profitable to all concerned to have the design as it should be.

It seems to the writer that the chief reason why the idea prevails among so many that the derived factors or values can be juggled arbitrarily, as can the fundamental or absolute values, is that, previously a distinction has not been emphatically drawn between them, showing that they will no more mix than will oil and water.

Another reason is that a number of the factors have at sometime been fixed by the manufacturers, or some other authority, and the reason for this largely forgotten, or an analysis is not made to see why they were so fixed. In other words, it is not understood that practical considerations fix the absolute values, and therefore, the others are a mathematical result.

Still another reason is that some not knowing that the factors involved in a brake "lay out" are composed of arbitrary and derived values, mix them indiscriminately and give an arbitrary value to one that must have a derived value. For example, they think that the auxiliary reservoir volume can be

arbitrarily fixed, when, as a matter of fact, this cannot be done.

So much then for the considerations where the problem commenced with an arbitrarily chosen braking ratio.

Stops in a Brake Lay Out When Braking Ratio is Not Arbitrarily Chosen.

We will reserve for the present our conclusions from the discussion of this first problem and will now consider the second, namely, that one in which either the length of stop or the rate of retardation in miles per hour per second is specified. In this, all the factors of the preceding problem necessarily enter. However, this problem must be approached in an entirely different manner. It should be obvious that other data must be either known or assumed, after which the braking ratio that must be employed is fixed unalterably by a strictly mathematical relationship.

First, we must ascertain the retarding force necessary to produce the specified stop or retardation; then whether the length of stop desired or the retardation in miles per hour per second specified is a physical possibility and to do this, we must either determine or assume the capacity of the rail for adhesion.

To arrive at this, we must work with the figures given in the specification which we will assume to be a stop in 1000 feet from a speed of 60 M. P. H., and in a second case, a retardation of 3.0 M. P. H. per sec. from the same speed. In furnishing the specification for the retardation, it is obviously both necessary and possible to include the weight of the vehicle therein, which in our case we will take to be 100,000 pounds. We now have all the factors from which to ascertain what our average retarding force must be, namely, (a) a speed of 60 M. P. H. (b) weight of vehicle in pounds, (c) distance in which the stop has to be made, that is, the retarding force in pounds will equal one-half the weight of the vehicle divided by 32.2 times the square of the speed in feet per second divided by the length of the stop in feet. For the first case taken, the retarding force will be, therefore, $(\frac{1}{2} \times (100{,}000 \div 32.2) \times 88 \times 88) \div 1000 = 12{,}000$ lbs. For the second case, the retarding force is secured by changing the M. P. H. to feet per sec., dividing by 32.2 and multiplying by the weight of the vehicle, that is, $(3 \times 1.466 \div 32.2) \times 100{,}000 = 13{,}630$ pounds, the retarding

force required to meet these specifications. With the average retarding force now known, the next step is to convert this to the braking ratio required, and to do this, we must know the characteristics of the physical equipment to be employed; that is, the coefficient of friction which will be realized (and in the case we are considering, we will assume that the maximum and minimum coefficient realized varies but little from the mean which we may well do under the conditions); the efficiency of the foundation brake rigging; the maximum cylinder pressure attainable, and the time in which the maximum cylinder pressure is obtained. The combination of all these will fix the braking ratio required as shown by the following.

We have a coefficient of friction of 10 per cent and an efficiency of foundation brake gear of 90 per cent, a maximum cylinder pressure of 100 pounds and a retarding force required of 12,000 pounds. For the first case, the braking ratio will then be 12,000 ÷ (.10 × .90 × 100,000)=133%. This however, is without taking into consideration the time required to get the brake fully applied which in the equipment we are considering is in a mean time of 1 second. This is equivalent to the vehicle running 1 second or 88 feet without the brakes applied. Therefore, the stop must be actually made in 912 feet which will require an average retarding force of (½ × (100,000÷32.2) × 88 × 88)÷912=13,140 pounds. Therefore, the actual braking ratio necessary is 13,140 ÷ (.10 × .90 × 100,000)=146% (See Page 171).

The next step is to satisfy ourselves that this braking ratio is possible of employment without the likelihood of wheel sliding, and to do this, it is necessary to know whether or not the brake shoe pull required will exceed the rail pull on the wheel. Since we know that from 20 to 25 per cent of the weight of the vehicle on the rail can be realized in rail pull, or adhesion, it is clear that we are entirely within the limit, since the brake shoe pull will be 1.46 × .90 × .10=13% of the weight of the vehicle, while the potential of the rail is 20 per cent of the weight of the vehicle. We will not work out the second case as it would be merely a repetition.

Complexity of Subject.

From the foregoing analysis of the second problem, which

has resulted in obtaining a braking ratio to meet the specification, it is clear that we are now back to where we divided the problem on Page 182, and can therefore proceed to make our brake lay out exactly according to the procedure set forth on Pages 182, 183 and 184, and thus are in a position to assert that what has been said demonstrates that there is much more to the problem of a brake installation than the mere addition of cylinder pressure to the per cent. braking ratio, and we think all must join in the conclusion deduced from this analysis that a brake design and lay out is by no means a simple proposition and that, involving as it does so many factors, proportions, and relationships, it requires very careful study and consideration if inefficient and unsatisfactory installations are to be avoided. Fortunately, many of these proportions and relationships are in the hands of the manufacturer, and, therefore, have become largely fixed, and it is in the endeavor to fix those which are not fixed or controlled and are therefore shuffled to suit various whims in attempted betterment that this exposition has been prepared.

CONCLUSION.

The foregoing analysis is necessarily quite lengthy, still it is not complete, at least as far as the reasons for some requirements are concerned. It is a long and obtuse subject, particularly when all that is involved is considered. So far as the writer knows this is the first time that the braking ratio problem or science has been treated comprehensively, the usual discussion being only of parts or phases or sections, which has only served as a rule to make confusion worse confounded, both in practice and when real problems have presented themselves. Doubtless some opine that what has been here presented has not made the matter simple by any means. No, but neither does a text book on any science, Calculus, for instance. Its purpose and usefulness consists in developing the science completely, which, of necessity, leaves simplicity, or otherwise, as a quality of the subject—this being greater or less to the individual according to his aptness and previous knowledge. It must, of necessity, leave comprehension and understanding to the patience and diligence of the student, whose competency, both to judge of its

value and to use it in practice, will depend upon how completely he gets to know it and his ability to apply it in practice.

The writer has endeavored to make this exposition complete and clear enough for whosoever desires to master the subject, but though he who runs may read, he who does no more will not get far with such a complex and ramifying subject as this. The writer respectfully requests careful study of the *whole subject* as otherwise it will be quite easy to reach different conclusions from those expressed herein.

The writer has followed his usual method of stating both the facts and the reasons for them; therefore, whoever desires to abreviate the discourse can extract the facts, leaving out the reasons. "Brevity is the soul of wit (wisdom), "I have heard, and "soul" properly expresses it, for when such a subject as is here considered is so expressed, it is about as workable a proposition as is a soul without a body. Whatever responsibility exists for its length must rest with the subject and not with the writer, since he is not creating it but merely expounding it.

PRESIDENT: The subject is now open for discussion. The speaker has very kindly offered to answer any question you may wish to ask upon any phase of the subject.

MR. CHAS. A. LINDSTROM: We have listened to a paper on a subject of much interest to all of us, and which has been very thoroughly explained—although it may be a little too technical for some. But it includes everything that can be wished for on the subject. If there is anything we don't know we have the opportunity to read the paper when it is printed, and find it there. However, I have made a few notes which I wish to touch upon.

Mr. Turner made in the beginning a great difference between braking power and percentage power, and also laid great stress upon the foundation brake system. I do not know what he means by the inefficiency of foundation brake. There can be nothing else to prevent proper result, if the foundation brake is properly designed, to give the required braking power with the available air pressure than friction in the parts and pins and guides and similar details. In a design of brake with 90 per cent braking power, the foundation brake is laid out with a given cylinder power so that it will give 90 per cent braking

power, then we have that percentage of power. If it is not designed right we haven't got 90 per cent. All the deficiency that can exist in the foundation brake is friction, lack of proper clearance, resulting in inability to get proper travel.

Of course you cannot say that you have a certain braking power and have it efficient unless it is based upon the weight of the car. Generally speaking 90 per cent braking power is the braking power used on passenger trains, whereas on freight trains 70 per cent is used. Mr. Turner has failed to say that these percentages are based on the empty weight of the cars. He has said they have brought the braking power up to 150 per cent. I question whether it is possible to brake a car 150 per cent of its empty weight if it is empty, without sliding the wheels. Mr. Turner may not know it, but his predecessor, Mr. Arthur Johnson, and I made a number of tests on the Pennsylvania Railroad fifteen or sixteen years ago and the Air Brake Company tried to use 120 per cent braking power with a speed of 60 miles per hour, and there wasn't a second's time after the application until every wheel on that train was locked tight, and we had to remove and replace 36 pairs of wheels from the cars in the two trains used in the test on account of flat from sliding. It may be possible to use 150 per cent braking power on the underground railroads in New York, but, if so, is it not because the cars as a rule are always loaded?

Another thing, percentage braking power is altogether a question of efficiency coefficient between the wheels and the shoes. You can not put 150 per cent braking power on a cast iron wheel with a cast iron shoe, you lock the wheel every time you do it. You may do it with steel wheels and steel shoes but not with the iron shoe which is known as No. A Altoona shoe, a soft iron shoe. This shoe under high pressure produces a friction so great that the coefficient of adhesion between the wheel and the rail is overcome and the wheel slides.

It was mentioned that certain railroad men could not understand why 80 pounds pressure in the cylinder will not slide the wheels any more than 60 pounds will. The speaker failed to explain that that is a question of foundation brake. If you design a brake for 90 per cent braking power with 60 pounds pressure, and then use 80 pounds in the cylinder, you may slide the wheels, but if the brake is designed to use 80

pounds the wheels will not slide any more than with 60 pounds as the brake power will be 90 per cent with both pressures.

It was also stated that the air brake cylinder had nothing to do with the braking power. That is correct to a certain extent. The pressure in the cylinder and the braking power is only a matter of piston travel. If we have a car weighing 100,000 pounds and use 90 per cent braking power we have 90,000 pounds to be braked. Suppose we have ½″ travel between wheels and shoes for slack, we would have one-half of 90,000 inch pounds or 45,000 inch pounds. With a 14″ cylinder and 60 pounds air pressure we get a total pressure of about 9200 pounds, which divided into 45,000 gives practically 5″ piston travel. The same work may be done with a 10″ cylinder which has a total pressure of only 4700 pounds, but instead of 5″ travel we get 10″ travel. Therefore, while the size of the cylinder has nothing to do with the braking power it has a great deal to do with the efficiency of the brake.

As regards what the car builders do in the shops with the foundation brake: The car builders have very little to do with designing the foundation brake. We haven't the opportunity to go down to New York and do like an Air Brake Company can do. We cannot go to a car purchaser and say "Improve the stop" because we don't know anything about the stop for obvious reasons and we might be told to "mind our own business." Expected purchasers of cars come to us and say "We want a certain number of cars and we want to use 90 per cent brake power with 60 pounds pressure in the cylinder and we want to put on a certain size cylinder and reservoir, as made by the Air Brake Company." They buy the air brake equipment and we put it on and proportion the foundation brake to suit the air pressure and the percentage of brake power. One railroad company uses steel wheels and steel shoes, and another company cast iron wheels and cast iron shoes, in the selection of which the Car Company is not consulted.

I don't think you meant it seriously when you said that this is the first time Mr. Lockwood knew about the calculation of the brake. I think you are right that this is the first time it has been put in the shape you put it in.

MR. TURNER: That is all I said.

MR. LINDSTROM: I thought you said Mr. Lockwood

now knows something he didn't know before. As I said before, we may know these things, and Mr. Lockwood knows and a good many other car biulders know it, but we are not allowed to use it. We know what friction is. We don't know what your proportions between air brake reservoir, valve opening, cylinder, etc. are; we don't know anything about it, it is not in our line of business. The railroads tell us what brake beams and shoes and air brake hose and what size of cylinders to use and all we have to do is to see that the brake power they want is taken care of in the foundation brake. We have the weight of the car, the slack, the size of the cylinder, the air pressure and the percentage power to go by, and it does not make any difference whether you put in screws or wedges or levers between the brake beams and the cylinders it will give the same result if it is correctly proportioned, and to that extent the foundation brake is correct as far as it can be made by the Car Builders.

By the way, deflection in the foundation brake is a good thing provided it is not so great that the parts will take permanent set. If a brake gear could be made so flexible that it would just like suck on to the wheels we would have a much more effective brake than if it would go bang and stay there.

PRESIDENT: Will you answer that now?

MR. TURNER: Mr. President, I think I will have to reply to Mr. Lindstrom by taking the last first. I think the first thing is regarding the statement that now Mr. Lockwood could go ahead. What I said was, if you understood the sense in which I was talking, that I had followed through several phenomena. I stated that we had to know what the weight of the car was; what the coefficient of friction was; what the time required to get air in the cylinder was; and various other things, provided we wanted to make a 1200′ stop. And when we had found out by experiment, previous knowledge, assumption, or anything else, that Mr. Lockwood or any man was now in a condition to go ahead and make his brake lay-out. That was the remark I made.

It is true, answering again another phase of your question, that you have nothing to do with that, and I took care of that in the paper, as you will find when you come to read it. You will find that I said in the paper that, when the car

builder is furnished with a certain percentage ratio by the railroads for whom they are building cars, all they are concerned with is in making an efficient foundation brake and putting it in. All they have to know is two things; the size of the brake cylinder—they do not even have to know that if they know the ratio of the shoe pressure to the weight of the car and the ratio of leverage required, which is practically determined by the size of the cylinder furnished by the manufacturer, and then they are in position to go ahead and put in a brake gear design. But that is an entirely different proposition from the one I was considering at the time with which your remarks are concerned. I was concerned then with a railroad company coming to ourselves, or their own engineers, and stating "We desire this train to be stopped in 1200′". Then neither Mr. Lockwood nor any other man is in a position to go ahead and work out his foundation brake gear because he must know these things; he must know the time it takes to get air into the brake cylinder from the time it commences to flow; and he must know the time it takes to get the last brake on in the train from the movement of the engineer's brake valve; and he must know the coefficient of friction between the shoe and the wheel; and he must know the efficiency of his brake rigging, which brings me up to your other question.

I mentioned that the foundation brake gear varied in efficiency all the way from 65 to 95 per cent, so you will see that there is a great difference in foundation brake gears. For instance, if you take a single shoe brake you will find as a general proposition that it will transmit much less of the cylinder pressure than will a clasp brake, due to the distortion caused by the tremendous forces that are met; the fact that the car weight shifts and the shoes follow down on the wheel; the position of the hangers, the bending of the rods and levers, and a hundred and one other things. So there is a vast difference between the foundation brake gears, not only as between single shoe designs among themselves but also between single shoe and clasp brake designs. The Pennsylvania Railroad spent thousands of dollars to eliminate the losses of several designs of foundation brake gear. I want to tell you that as between two foundation brake gears of the clasp brake type and two of the single shoe type we had differences of 300′ in stopping

due to no other cause whatever than a difference in foundation brake gear design. So that should settle in your minds once for all that there is a vast difference in efficiency in transmitting the pressure from the cylinder to the shoe, and that there is a vast difference in designing foundation brake gear.

MR. LINDSTROM: You failed to say in that part of your paper which you read that you included the brake shoe in your foundation brake gear.

MR. TURNER: No, I stated that by foundation brake gear I meant everything from the piston of the cylinder to the shoe against the wheel, in fact, right down to the rail.

Coming to your next proposition, about the percentage of braking power that can be used, I tried to make clear in the paper that there were four factors in fixing the percentage braking ratio that could be employed. For instance, if you take a 50,000 pound car such as we had a few years ago, it was practically impossible to go much beyond 100 per cent ratio because as you say you would slide the wheels. But you will be surprised to know that we are braking hundreds of cars today at anywhere from 150 to 180 per cent, steam railroad cars at that, on the empty weight of the car. This paper deals exclusively with passenger cars, and we went as high as 220 per cent at Toledo.

MR. LINDSTROM: You had steel wheels and steel shoes.

MR. TURNER: No, cast-iron shoes. We have never made any tests with steel shoes in my experience. They were Pennsylvania shoes, which are soft, and those last tests at Atlantic City were all made with gray iron shoes, soft shoes. And the braking power used was as high as 180 per cent right straight along at Atlantic City, and we have no thought of efficient braking on modern cars at less than 150 per cent today. For years the ratio on passenger cars has been 125 per cent, so the fact that at one time it was impossible to use more than 100 per cent has no bearing upon the situation today. I had to turn over the pages bearing on this phase of the subject, in my reading. The brake shoe performance varies as much as 300 per cent and it is altogether the quantity of work done that determines the efficiency of the brake shoe. For instance, at

the tests at Toledo I came to this conclusion; that the old idea of brake shoe friction as we commonly took it, or as I understood it at least, was all rot. In other words, all the laws of friction such as we have in the old text books are false; that friction is independent of pressure and bearing surface, or things of that sort. On the contrary, that the opposite is true, that friction, pressure, time, and speed have a vast influence upon the friction of the shoe. Finally, I tried to run this thing down and I started out on the method I have largely employed in my work; of exclusion and elimination, or of extremes. That action and reaction are equal and in opposite directions and that extremes meet we all know.

Since we knew that the coefficient of friction varied for a brake shoe, the thought occurred to me once, at what point does it reach a maximum. I reasoned it out this way; that if I got a shoe infinitely cold, down to absolute zero, that shoe would have very little friction negligible as far as we are concerned; and if we got it infinitely hot, which would be a gas, it would have little or no friction. Without going to the extreme of a gas, if we got it molten it would have no friction. Since it had none when at its coldest and none when at its hottest, there was some point between these where it had its maximum. The question was, where is that point. I reduced all these influences upon friction, such as pressure, speed and time, to the one term of heat, and then I said heat is the thing that varies the coefficient of friction. Now then, I said to myself, where is that point where it has its maximum. It cannot be at atmospheric temperature because we know that the coefficient of friction rises when we first apply the shoe to the wheel for all types of shoes. The problem was to find out where it did reach its maximum, and by instruments such as electric thermometers and by observations made by removing a part of the car floor and looking through and seeing at what point the coefficient of friction fell as shown by the retardation curve, etc., on the chronograph, we found out, what I had previously assumed to be somewhere about 800° was not far from it. When the temperature reached 800° the coefficient of friction fell, and it would continue to fall until it would become negligible if the molten metal could be confined, were it not that when it got to a certain point the abrasion set up would present

a new surface right along and therefore we got a constant coefficient of friction. That coefficient started in at approximately 15 per cent and went up until it reached 18 or 20 per cent, depending on the composition of the shoe, etc., and then dropped down to approximately 10 per cent and staid there during the rest of the stop. You can see that the point at which it would reach this 800° was dependent upon the work it was doing at the time. And we can pick that out of the different runs just as easily as you can pick nuts out of raisins. Since we found that out and since under modern brake shoe pressures we are not concerned with the minimum coefficient of friction at all, because at low speeds we do not reach it before we stop and at high speeds we go beyond, we assumed that 10 per cent coefficient of friction was what we could employ for stopping a train, that 10 per cent was all we realized. At the time you were speaking about, you undoubtedly realized approximately 20 per cent coefficient of friction, due to the fact that the heat generated was so little that the coefficient of friction remained that high.

MR. LINDSTROM: We got 30 per cent.

MR. TURNER: If you could use 100 per cent in those days, then we can use 300 per cent today and be in precisely the same position you were in then, because we multiply by a factor of 10 per cent and you multiplied by a factor of 30 per cent, in the specific instance you mention.

To get back to the point, the braking force is altogether determined by the coefficient of friction which you realize. Therefore, it is possible with a heavy vehicle, such as we have today, to use as much as 300 per cent braking force without sliding the wheels, whereas with a lighter vehicle where the shoe has so much less work to do, if you used even 100 per cent, you would slide the wheels. That is the reason for the difference.

I don't know that there are any other things which you mentioned that I have not covered, but this is the difference between what you thought I said and what I actually said.

MR. J. R. ALEXANDER: It is embarrassing to try and criticize a paper so full of technical information as the one just heard, the more so when having only a narrow viewpoint of one who must see that the brake appliances do their full

share of the work and all too frequently what is more difficult to explain why it sometimes fails to do what everybody expects of it. It was not many years ago that the mechanical experts and the operating officers on the different railroads, of whom our friend Mr. Mitchell is one, could talk us to a stand still that the brake design, including the foundation rigging, was all that could be asked for and all our short comings on the road, such as rough handling of trains, flat wheels or over-running station stops was strictly up to maintenance or the operation of the brakes. In watching the development of the air brake art for a good many years I can heartily endorse the views as heard from Mr. Turner, which are based on the information received from actual tests and should in no way be taken to represent the visionary fancy of a figure artist. This data is especially interesting along the lines of the three factors he refers to as being so essential to keep in mind where it is desired to design a perfect and efficient operating foundation brake gear. In other words, if I recall correctly, the first was to quickly obtain maximum cylinder pressure. In addition I take it for granted the writer has in mind that we must not forget anything already learned as to the importance of keeping hold of cylinder pressure. There is a good deal to learn yet as to the value of keeping cylinder pressure until the work for which it is put there has been completed.

The second one is to make sure to have the desired efficiency in the brake gear. I understand that to mean that the total air pressure placed against the piston in the brake cylinder will be delivered to the brake shoe and transferred to the wheels. This is the feature of brake design that has been sadly neglected until within the past two or three years.

The third and possibly the most important is the work performed by the brake shoe. In fact, where the first two factors mentioned are not maintained the desired results will not be obtained. On the other hand with the up-keep of the first two and the proper design and style of brake shoe is not employed the results will still not be satisfactory. When hearing the speaker tell about the importance of the coefficiency of the brake shoe I wonder whether he would agree with us that with a single brake shoe design it is possible to get such an excessive temperature on the shoe during a stop or from a

hard holding train on a heavy descending grade that with the next stop the shoe will be found much less efficient than it was previous to the time of its being so highly overheated. In other words, when heated to about the fusing point of the metal does the shoe after cooling off take on a very hard glazed surface so that with the next stop you have a condition of shoe that will not be at all effective for braking purposes.

I am very glad indeed to have heard the reading of this paper and its discussion.

MR. R. H. BLACKALL: I do not know that I have anything to add to the subject. While Mr. Turner was reading the paper, the latter part particularly, I was complaining to myself that my head was not a larger sponge than it is. My little sponge seemed to get saturated and from then on the figures, etc. just struck and spattered off.

It was certainly a most enjoyable and instructive paper to me.

Mr. Turner has covered the ground so thoroughly and so ably that there is little left to say. The paper is not one for discussion but is one rather where conclusions have been drawn after exhaustive and elaborate tests were made.

Not having been in the air brake business in some years, I have not been in touch with recent experiments, but I can appreciate very fully, however, the great importance which the various fundamental points referred to have, also the vital bearing these have on the maximum braking power that is possible.

Someone spoke of objectionable wheel sliding with 150 per cent braking power on passenger cars. I can remember a test where we had 242 per cent on a single car and the stop was made without any damage to the wheels.

There is absolutely no question but what much higher braking power can be used, especially when all vehicles are equipped with the same percentage of power.

While I have referred to a case where 242 per cent braking power was used with no damage to the wheels on a single car, I can also refer to a case where considerable wheel sliding occurred in a train having cars equipped with 70 per cent while others had 90 per cent braking power. The wheel sliding

occurred, however, on the cars having the 90 per cent braking power. This was some years ago and the road, I believe, was the N. C. & St. L. which road was considering the advisability of cutting the braking power on all cars to 70 per cent. It was suggested that the braking power be made uniform and raised to 90 per cent, since other roads were using this percentage. Upon raising the power to 90 per cent the wheel sliding was eliminated.

Most all of the wheel sliding occurs after the speed of the train has been somewhat reduced, and, of course, with heavier equipment, and with much higher braking power than has been used in the past, the tendency would be for the brake shoes to more nearly approach the fluid state, and the percentage of braking power would automatically reduce, due to the change in the metal of the shoes, to a point where little wheel sliding would result.

There is absolutely no question but what the percentage of braking power can be greatly increased over what is generally in use today, the only question is, how much.

MR. H. H. MAXFIELD: Mr. President, I would like to move a vote of thanks to Mr. Turner for his scholarly and valuable paper. This Club is fortunate to have in its Official Proceedings a paper of such scientific and practical value; and is especially fortunate in being able to obtain such an eminent authority as Mr. Turner to present the results of his investigations on such a timely and important subject.

MR. TURNER: Before the discussion is closed I would like to say this one word with regard to these recent experiments and the deductions and formulae that have been made from them, and that is this, that they have the virtue of being different from theory because they are actually practical. In other words, we as an Air Brake Company, and any railroad man, can by taking these figures and formulae, so brake a car as to obtain any stop, any control that is desired. I do not want you to go away with the thought that these are all mere theoretical matters. They are being put in practice every day and at present form the basis for all air brake designs that are considered from an engineering standpoint in this country, and, therefore, you need have no fear whatever in

taking them as demonstrated facts. I want to thank you for your very kind appreciation this evening.

The vote of thanks was carried by a unanimous vote.

On MOTION adjourned at 10:45.

J. B. Anderson
Secretary.

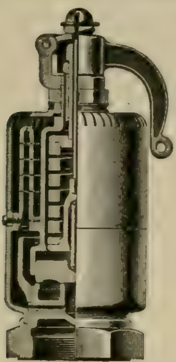
OFFICIAL PROCEEDINGS

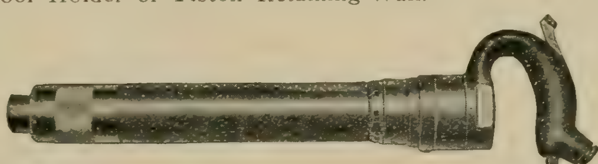
RAILWAY CLUB OF PITTSBURGH

$1.00 Per Year 20¢ Per Copy

Vol. XIII. MAY 22, 1914 No. 7.

"Some Ill Effects of Boiler Feed Waters and their Causes"
By W. A. Converse, Secretary and Chemical Director,
Dearborn Chemical Company.





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OFFICIAL PROCEEDINGS

OF

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F. H. STARK.............................November, 1905, to October, 1907.
* H. W. WATTS...........................November, 1907, to April, 1908.
D. J. REDDING...........................November, 1908, to October, 1910.
F. R. McFEATTERS........................November, 1910, to October, 1912.

* Deceased.

Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING,

MAY 22, 1914.

The regular meeting of the Club was called to order by President, A. G. Mitchell at the Monongahela House at 8 o'clock P. M.

The following gentlemen registered:

MEMBERS.

Adams, Lewis
Amsbary, D. H.
Anderson, J. B.
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Babcock, F. H.
Barney, Harry
Barth, J. W.
Battenhouse, Wm.
Brooks, W. A.
Buffington, W. P.
Bugle, G.
Butler, W. J.
Chapman, B. D.
Chilcoat, H. E.
Code, J. G.
Cotton, A. C.
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Cooper, F. E.
Cooper, J. H.
Cooper, Wm. M.
Copeland, F. T.
Coulter, A. F.
Crouch, A. W.
Courtney, D. C.
Curtis, Wm. R.
Deagen, John J.
Drayer, U. S.
Duggan, E. J.
Felton, F. J.
Fogle, E.
Funk, S. R.
Geddes, J. R.
Glassburn, S. G.
Gross, C. H.
Harriman, H. A.
Hays, M. D.
Haynes, J. E.
Heird, G. W.
Henderson, J. W.
Herrold, A. E.
Howe, D. M.
Huchel, H. G.
Hudson, W. L.
Hunter, J. A.
James, J. H.
Kelly, H. B.
Kinch, L. E.
Kinter, D. H.
Koch, Felix
Lansbury, W. B.
Lindstrom, Chas. A.
Lobez, P. L.
Long, R. M.
Lynn, Saml.
Lyons, Robt. S.
MacQuown, H. C.
Maxfield, H. H.
Mensch, E. M.
Millar, C. W.
Mitchell, A. G.
Mitchell, John
Mott, Saml. L.
Murphy, W. J.
McAbee, W. S.
McFeatters, F. R.
McNulty, F. M.
Neal, J. T.
Neel, T. M.
O'Connor, M.
Penn, Wm.
Patterson, J. E.
Peach, Wm.
Phillips, Lee
Porter, H. V.
Pulliam, O. S.
Redding, D. J.

Reymer, Chas. H.
Rice, D. S.
Richardson, L.
Ritts, W. H.
Root, E. E.
Sewell, H. B.
Sheets, H. E.
Sleeman, Wm. C.
Smith, J. H.
Smoot, W. D.
Snyder, J. W.
Stark, F. H.
Straub, V. V.
Stucki, A.
Swope, B. M.
Thurlby, A. R.
Trappe, W. C.
Travis, J. H.
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Watkins, G. H.
Wertz, P.
White, F. L.
Williams, W. W.
Williamson, J. A.
Wood, R. C.
Wyke, J. W.

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Bair, A. H.
Borst, R.
Buckmaster, F. C.
BuMiller, G. A.
Cassidy, J. P.
Converse, W. A.
Evans, E.
Faddis, J. S.
Gowey, H. K.
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Steele, G. C.
Snitzer, N. E.
Wagar, S. J.
Wilson, E. H.
Wilson, G. E.
Yawman, C. A.

PRESIDENT MITCHELL: The calling of the roll will be dispensed with, the record of attendance being had through the registration cards.

The reading of the minutes of the last meeting will also be dispensed with, the Official Proceedings being in print and about ready to be mailed to the members.

The Secretary read the following list of applications for membership:

Adams, Chas. F., Enginehouse Foreman, Penna. R. R., No. 79 North First Street, Duquesne, Pa. Recommended by H. G. Scheck.

Bowden, T. C., Coal Inspector, B & L. E. R. R., Greenville, Pa. Recommended by A. D. Chittenden.

McMillan, G. W., Manager Railway Department, James B. Sipe & Co., Pittsburgh, Pa. Recommended by J. G. Code.

Schroyer, J. R., Salesman, Homestead Valve Works, Homestead, Pa. Recommended by D. J. Redding.

PRESIDENT: As soon as these applicants have been favorably passed upon by the Executive Committee the gentlemen will become members.

The Secretary announced the death of J. McC. Barwis, General Foreman Passenger Car Inspectors, Penna. R. R., Pittsburgh, May 20, 1914. Mr. Barwis was elected to membership in the Club April 2, 1904.

PRESIDENT: We are all sorry to hear of Mr. Barwis' death. I direct that a page be set aside in our Official Proceedings to record his death.

SECRETARY: We have the following resolution which is submitted for adoption:

"WHEREAS, the members of The Railway Club of Pittsburgh and their ladies were invited to and tendered a complimentary concert at Carnegie Music Hall, Schenley Park on Thursday evening, May 14th, 1914, by the Pittsburgh Male Chorus, assisted by Mrs. Elsie Gundling Duga, soprano, through the courtesy of The McConway & Torley Company of Pittsburgh,

AND WHEREAS, a large number of the members of this Club with their ladies accepted the invitation and attended the event to their enjoyment and passed a most delightful evening,

BE IT RESOLVED, that a vote of thanks be and hereby is tendered to The McConway & Torley Company for the courtesies and entertainment provided on this occasion, and that a copy of this resolution be forwarded to The McConway & Torley Company and also be spread upon the minutes of this Club as a permanent record of the event."

(Signed) L. H. TURNER,
D. J. REDDING,
F. R. MCFEATTERS,
Executive Committee.

The resolution as presented was adopted by a unanimous rising vote.

PRESIDENT: If there is no further business we now come to the address of the evening by Mr. W. A. Converse, Secretary and Chemical Director, Dearborn Chemical Company, Chicago, on the subject of "Some ill effects of boiler feed waters and their causes."

SOME ILL EFFECTS OF BOILER FEED WATERS AND THEIR CAUSES.

By Mr. W. A. Converse.

Mr. President and members of The Railway Club of Pittsburgh:

As a matter of preliminary remarks, I want to assure you it is with pleasure that I am with you this evening. I have met a number of you many times in the past and I appreciate very much the acquaintance of the members I have met. The talk I am to give you this evening is not one that would be classed as formal. It is going to be strictly an informal talk and I want you to feel at liberty at any time, preferably at the end, to ask any questions, and I wish to impress upon you at the start that it will be a pleasure to answer them as far as I can intelligently, and to enter into a discussion of any phase of any of the features I may bring out.

You will recall that the subject as announced is "*Some* of the ill effects of boiler feed waters and their causes." Do not lose sight of the word "some." If I were to undertake the discussion of all the ill effects of boiler feed waters even to the most meager extent we probably would be here a couple of weeks from tonight in a continuous session. There are many ill effects with which you are thoroughly conversant, but which in a great many cases you are at a loss in your own minds, no doubt, to understand the reasons therefor, and whether all these ill effects are attributable to the boiler feed water or not.

The trend of the discussion tonight will be first to consider water as we obtain it from its natural sources, and then to take up some of the more important ill effects arising from its use, the theories that have been advanced for the cause thereof, and some of the investigations that have followed, in an endeavor to confirm or reject these theories. If we are to thoroughly consider and clearly understand any particular subject, it is necessary that we have a general idea of the fundamentals underlying it, hence if we are to consider the substance boiler feed water, we must have some knowledge of what water is; and since the chemical composition of pure water plays a large

part in these effects, it becomes essential that we consider it from this point of view.

Digressing for a moment, if I should at times repeat various statements, it is that I may call to your attention more plainly the points I am endeavoring to bring out.

Water to the technical man is water in an absolutely pure state, devoid of all foreign substances, either gaseous, liquid or solid. Chemically, water is made up of two gases, hydrogen and oxygen. Hydrogen gas when pure is odorless, colorless, tasteless, and non-poisonous. It has, however, the property of inflammability. If we should pass hydrogen gas through an ordinary gas jet and light it, it would burn in the same manner as does illuminating gas.

It would not, however, give us the illumination, because of the absence of carbon. Oxygen gas has identically the same properties as hydrogen, with one exception, i. e., it is entirely devoid of the property of inflammability. It will not burn, but it is absolutely essential to all processes of combustion. If it were not for this fact and the fact that a large part of the atmosphere which you allow to pass into the furnaces under your boilers, is made up of oxygen, you would not be able to obtain any efficiency therefrom, because there would be absolutely no combustion of the fuel.

Going back to the composition of water, we will assume that we have three rectangular containers of identical capacity, one of which is filled with oxygen and the other two with hydrogen. If by any method we cause the two volumes of hydrogen to combine chemically with the oxygen we will produce water, and if the gases were pure we would naturally produce absolutely pure water. There are two ordinary methods for bringing about this combination. First, if we should pass hydrogen gas through an ordinary illuminating gas jet and burn it as we do illuminating gas, we would simply cause it to combine with the oxygen of the atmosphere and produce water. For every unit of hydrogen so burned we would produce a certain and definite amount of water. Again, if we take the two parts of hydrogen and the one of oxygen and mix them in a container of any type, the same as we might mix sawdust and sand, and cause an electric spark to pass through that mixture, it will result in a chemical combination of the two gases, producing water.

For our purposes this evening we may assume that water has its origin at the surface of the earth, in seas, inland lakes, rivers, creeks, etc. The effect of the heat rays of the sun upon these surfaces is to convert the moisture thereof into vapor, which rises invisibly into the heavens, later assuming the form of clouds, in which condition it is visible. The water supposedly exists in these clouds in a semi-condensed condition; that is, it is partially condensed, but the particles of water are so small and so finely divided that it does not readily fall through the atmosphere, but due to electrolytic disturbance or change of temperature, or both, these extremely minute particles of water combine one with another and form larger particles, which in turn fall to the surface of the earth. Water falls to the earth in several different forms, as rain, snow, frost, dew, etc. However, we will consider it only as falling in the form of rain.

It is believed that water as it leaves the clouds is in a practically pure condition, and that the first opportunities for its contamination arise immediately following the beginning of its descent to the surface of the earth. In falling through the atmosphere, either as rain or otherwise, it takes up certain substances. Naturally these substances taken up are dependent upon the substances contained in the atmosphere through which it falls, which in turn are to a large extent due to the industrial conditions existing upon the surface of the earth. But there is one substance always present in the air, and that is carbon dioxide (CO_2) or carbonic acid gas. You as men interested in the production of power from the combustion of coal realize that CO_2 is the constituent of your flue gases or your stack gases upon which you base your opinion of the accuracy or the perfection of the combustion going on in your furnaces. In a district where bituminous coal is the chief fuel, and where this fuel is largely impregnated with sulphur, which is the case generally with the middle states bituminous coal, the sulphur, in the process of combustion is also converted into another gas just the same as is the carbon into CO_2 gas. This sulphur gas naturally impregnates the atmosphere and is dissolved by water falling through the air, and eventually converted into sulphuric acid. As the term sulphuric acid may be Greek to some of you, I will just call your attention to the fact that sulphuric acid is of such a character that when in even a weak solution in water

it will dissolve metallic iron very rapidly. There is also present in the atmosphere, at all times, another class of substances commonly known as the ammonia class. You are all conversant with ordinary household ammonia. The ammonia in the air is the same substance, but not present in sufficient quantity to give the odor. The atmosphere carries some of this in practically all neighborhoods at all times, consequently more or less of this class of substances becomes a part of the impurities contained in natural waters.

Assuming now that the water has passed down through the atmosphere and has reached the immediate surface of the earth, it has taken up some carbon dioxide (CO_2), some ammonia, undoubtedly some sulphur gases, and probably some oxygen (since the air is made up, to the extent of twenty per cent, of this gas)—all of these gases being in solution in the water itself.

What happens at the immediate surface of the earth? That depends upon the litter or refuse which covers the surface of the earth upon which the water falls. If the surface is strewn with decaying or rotting vegetable matter, such as timber, leaves, twigs, etc., it takes up another portion of carbon dioxide (CO_2), because the process of rotting of timber, for instance, is nothing more nor less than a slow process of combustion, identical in character in every chemical respect with that which is going on underneath your boilers; that is, a combining of the oxygen of the atmosphere with the carbon of the fuel which you are burning, or the carbon forming the greater part of the vegetable matter which is in process of decay. The only reason you do not notice heat or light in the case of the decaying of vegetable matter is because the rate at which the oxygen of the atmosphere combines with the carbon of the decaying timber is not sufficiently rapid. If the combination in the process of decay were going on as rapidly as it is in your furnace, you would perceive temperature and light as well. If the water falls upon a surface strewn with animal matter like we have in the stockyards district in Chicago, where there is more or less animal matter which is converted into ammonia compounds, it takes up more ammonia at this point. Then, again, animal fats like tallow and lard are made up in part of fatty acids, and these fatty acids are rather soluble in water, and are readily taken up in moderate

quantities by water coming in contact with them, and are extremely destructive to metallic surfaces. These are only a few of the substances that are commonly taken up just at the surface of the earth.

If we now follow this water down through the channels of the earth, whether or not perpendicularly through what we call veins, from whence it is later obtained through wells or springs, or whether it travels through channels corresponding to our rivers and creeks, another class of substances is taken up. You noticed that the bulk of the substances taken up previous to this were gaseous in form. Some solid matter is, however, usually taken up at the surface of the earth, but it usually consists of organic substances, which we will not discuss in detail at this time.

We know that water is the greatest solvent for all substances known; that is, water will dissolve some of more substances and more of some substances than any other liquid known. There is practically nothing that is absolutely insoluble in water. This can not be said of any other substance that might be considered as a solvent. The solvent action of water is further influenced by the substances which it has taken up through its travels down through the strata of atmosphere, at the immediate surface of the earth, and while traveling down through the earth. For example, let us consider carbonate of lime (ordinary lime stone). If we were to pass distilled water down through a layer of limestone, we would find that it would not take up or dissolve a quantity exceeding 3½ grains per U. S. gallon. But upon analysis of waters that come to our laboratories from time to time we find quantities up to as high as 53½ grains. This means that 50 grains of the carbonate of lime in solution in this gallon of water is there simply because of the presence of carbon dioxide (CO_2) which had been previously taken up from the atmosphere or from the immediate surface of the earth, due to the decay of vegetable matter or otherwise, since 50 grains of carbonate of lime in such a water is held in solution by the carbon dioxide gas present. And this particular gas being very readily eliminated from water with a rise in temperature, the carbonate of lime must go out of solution when the water is heated. Water even at 140° Fahr. will give up a considerable portion of this carbon dioxide (CO_2), and if main-

tained at 212° Fahr. for a sufficient length of time will give up all its free and loosely combined carbonic acid gas, which would result in throwing out of solution these 50 grains of carbonate of lime, leaving in solution the 3½ grains only. I make this point here to show you why it is that carbonate of lime goes out so readily in ordinary open heaters, for instance, or in any appliance where water is heated even to a moderate temperature. Water from wells will often show deposition of carbonate of lime in a glass, if the glass is filled with the water and allowed to stand at ordinary temperature for a short time.

Following the travel of the water through the underlying strata of the earth, we find that it takes up many other and different substances, mostly solid and mineral in character. If the water in traveling down through the earth comes in contact first with a deposit of carbonate of lime commonly known as limestone, it will take up or dissolve a quantity of carbonate of lime, the amount which it will take up above 3½ grains per U. S. gallon being dependent upon the amount of carbon dioxide the water has previously accumulated in passing through the air and over the immediate surface of the earth, and the length of time the water remains in contact with the limestone. If in traveling through the earth it comes in contact with a deposit of sulphate of lime, or what we know in its natural state as gypsum, we would naturally expect that the sulphate of lime or gypsum would be the predominating substance in the water. That is true in a sense. It is not necessarily true, however, because of this fact: if the water had previously come in contact with a deposit of carbonate of soda (soda ash) it would not dissolve or take into solution any appreciable amount of sulphate of lime. On the other hand if it had come in contact with a deposit of salt (chloride of soda) before passing through the deposit of sulphate of lime (gypsum), it would take up a very much larger amount of sulphate of lime than otherwise would be the case. You will see from this that the amount of the different solid substances a water may contain is to a considerable extent at least, dependent upon the kinds and quantities of other substances previously taken up and present in the water at the time of its coming in contact with another substance.

In similar manner we could go on and consider each and every substance taken up from the earth, commonly found in

natural waters, such as carbonate of magnesia, sulphate of magnesia, sulphate of soda, etc. However, time will not permit of this.

So you see as we go from the clouds on down to the source from which you railroad men obtain your water supply, there are many opportunities for extreme contamination of the water as compared with its original condition, i. e., the condition in which it existed in the clouds. In order to best arrive at the causes of the ill effects of some waters, it may be further advisable to consider some of the substances found generally in ordinary boiler-feed and natural waters. As a technical man, feeling that a considerable part of this audience has very little conception of what, for example, sulphate of lime really is, and what carbonate of lime really is, and other substances ordinarily found in water, I feel that it may not be time wasted to consider for a few moments the substances cited. I have prepared and here present a chart which shows the substances usually found. I am barring from consideration at present, suspended matter and some substances which may be considered later, if necessary. This chart shows all the substances which are found in practically all waters, those containing other substances being by far the exception:

CHART NO. 1.

TOTAL DISSOLVED SOLIDS

- Incrusting or Scale forming solids
  - Silica
  - Carbonate of Iron
  - Alumina
  - Carbonate of Lime
  - Sulphate of Lime
  - Carbonate of Magnesia
  - Sulphate of Magnesia
  - In presence with excess Of Carbonate of Lime
- Non-Incrusting or Corrosive or Foaming Solids
  - Sulphate of Soda
  - Chloride of Soda (Salt)
  - Carbonate of Soda
  - Chloride of Lime
  - Chloride of Magnesia

I desire to call your attention to a few of these. First, silica. What is silica? Nothing more nor less than ordinary, white sea sand, so to speak. If we analyze nice white sand we will find that upwards of 99 per cent of it is silica. Silica constitutes the base of our glassware, all of the enamels on our bath tubs, and all that class of material. Passing down to carbonate of lime, school crayon is the most common or ordinary form of this substance; all it contains other than carbonate of lime is a little binder to hold it together, and an abrasive substance like pumice stone to make it work satisfactorily for the purpose for which it is intended. Another common form of this substance is ordinary whiting.

Next we have sulphate of lime, well known to you as plaster of paris. In its native condition it is known as gypsum. Next, sulphate of magnesia (indicating). This is an interesting salt from more viewpoints than one. It is one of the things considered by some of us as mighty nice for use "the next morning after the night before," about two tablespoonfuls in a half-glass of hot water before breakfast. It is commonly known as Epsom Salts. It has another peculiarity. If you take a prescription from your family doctor, and walk into the neighboring drug store, and the prescription calls for an ounce of sulphate of magnesia, you will pay twenty-five cents for it. If you walk into the same store and ask for a pound of Epsom salts, you will pay ten cents for it.

Now, going down to sulphate of soda, chloride of soda, carbonate of soda, chloride of lime, etc., I will comment particularly only on the chloride of soda (common table salt). As all of you know, common salt is absolutely essential in the scheme of human economy. To chemists it is one of the very best examples of what can be done in the way of changing the chemical and physical properties of substances by chemical reaction. Chloride of soda or common salt is made up of two substances, one of them metallic sodium, which is vicious from every angle, and chlorine, which is even more obnoxious. Metallic sodium is so active that if we throw a piece of it on water it decomposes the water and ignites the hydrogen that is liberated, and gives off a report common to an explosion. A small portion of it placed on the skin would in a very few seconds bore down through the skin and finally go clear to the

bone. It is extremely poisonous when taken internally; in fact, it is so objectionable that the chemist himself uses extreme precaution in handling it. The other substance, chlorine, is a gas and is more obnoxious, more objectionable and more poisonous than metallic sodium. We bring together these two extremely objectionable and poisonous substances and cause them to unite chemically in certain proportions, and produce a substance that is not only harmless, but absolutely essential to the welfare of the human family; namely, chloride of soda or common salt. Such possibilities are true in connection with the salts common to boiler feed waters.

The next substance is sulphate of soda. I spoke a few moments ago of the action sulphuric acid would have in a weak solution upon iron. Sulphate of soda is simply a combination of that same vicious, metallic sodium and sulphuric acid. The sulphuric acid is also a very obnoxious material of itself, and since a solution of it will dissolve iron readily, it is extremely objectionable when present in a boiler feed water.

You will notice that the substances on the chart are divided into two classes; incrusting or scale-forming solids, and non-incrusting or corrosive and foaming solids. This means that all those substances shown under the former classification can and do enter into scale formation, these substances being the silica, carbonates of lime and magnesia, sulphate of lime, and sulphate of magnesia in the presence of an excess of carbonate of lime. Those coming under the latter classification, due to their extreme solubility, cannot and do not enter into scale formation; namely, sulphate of soda (Glaubers salts), chloride of soda (common salt), and carbonate of soda (soda ash). On the other hand, however, when present in a water in *relatively* large quantities, they do give rise to foaming, corrosion, and many other types of troubles. Since the chloride of lime is rather inactive, we will pass it by, and the chloride of magnesia will be considered later.

I feel that the most rational way of explaining the causes of some of the more common ill effects of boiler feed waters would be to consider the analyses of waters from several different localities, representing different types, which have been used in practice a sufficient length of time to enable us to know absolutely the effects of those waters, wherein nothing whatever

was used to counteract or change their ill effects. In referring to these analyses, I will cite the effects of the different waters, the theories that have been advanced to account for them, and the investigations that have been made to confirm or refute them.

ANALYSIS NO. 1.

Silica	.502	Grains	Per	Gallon
Oxides of Iron and Alumina	.093	"	"	"
Carbonate of Lime (Chalk)	.234	"	"	"
Sulphate of Lime (Gypsum)	None	"	"	"
Carbonate of Magnesia	.407	"	"	"
Chloride of Soda (Common Salt) . .	3.600	"	"	"
Sulphate of Soda (Glauber's Salts) .	8.214	"	"	"
Carbonate of Soda (Soda Ash) . . .	22.789	"	"	"
Undetermined Matter	.180	"	"	"
Total	36.019	"	"	"

The substances named on the charts are so arranged that those shown below the horizontal line never enter into scale formation, and those above do enter into scale formation, when present in sufficient quantity or relatively large proportions. Those below give rise to troubles of their own kind, more particularly foaming, corrosion, etc. I have selected waters rather heavily impregnated with substances, for the reason that you can more easily interpret quantities in whole numbers than in decimals.

Now what is to be expected of this water in the way of ill effects? It will foam, as we know from experience with waters of like kind. Why does it foam? You will notice that the larger portion of the non-scale-forming solids consists of carbonate of soda (soda ash). Carbonate of soda is nothing more nor less than soda ash. We find in the literature of today statements to the effect that a water devoid of suspended matter will not foam. Here is a water that does foam, and as far as the suspended matter is concerned it contains none. Neither does it contain a sufficient amount of any substances that, when submitted to the conditions extant in the interior of a steam boiler, would give rise to any appreciable amount of suspended

matter during an ordinary run between wash outs. We do, however, find a total of about 73 grains of the soda salts. They are soluble to the extent of several hundred grains per gallon, consequently they soon reach a point where they induce foaming, due to the fact that they change or increase the surface tension of the water in the boiler itself. You may say that a little matter of 22.78 grains of carbonate of soda is not much. It does not appear to be. But consider a stationary boiler developing 500 horse power continuously for 24 hours a day; it would evaporate about 45,000 gallons of water. The 22.78 grains per gallon is equivalent to 3.25 pounds per thousand gallons, therefore we would have 146¼ pounds of carbonate of soda in the boiler at the end of 24 hours. Imagine you are operating the boiler but fourteen days or two weeks; you would have 2047½ pounds in a boiler probably containing a quantity of water equivalent to about 3500 gallons. So you see you have a very concentrated solution remaining in the boiler, which would foam without question, and it did so from the second day in service following washout, at which time there was in the boiler not to exceed 130 pounds of the carbonate of soda.

Then another very deleterious condition arose here, viz., the disintegration and softening of gaskets, which in turn resulted in a leaky condition. Any chemist in the room will tell you that the gaskets upon the market today are largely made up either of asbestos or asbestos composition, or rubber or rubber composition. Asbestos is a mineral product, and we as chemists know that it is soluble to a considerable extent in a strong alkaline solution, that is, a solution of some of the soda salts. Asbestos as it exists in gaskets is in a very fine, fibrous condition, consequently when this strong alkaline solution comes in contact with it, the alkali naturally dissolves these fibers and causes a breaking down or change in the properties of the gasket itself, resulting in trouble. These are chemical facts and can be confirmed by experiment; consequently, are we not safe in assuming that it is due to the carbonate of soda, which is the only alkali contained in the boiler?

Now what about the effect, if any, upon the gaskets of the rubber type? If you will take an ordinary rubber band and place it in a strong boiling solution of carbonate of soda, or caustic soda, and allow it to remain there for say 48 hours, you

will find that the rubber band has changed very materially in character. It has its elasticity, it has swelled to several times its original size in diameter, and it has become of the appearance of cold glue or gelatin. If it can be shown that these substances in this solution alone will do these things, why should we not attribute these ill effects to the said substances contained in the water, where it predominates to the extent it does here? The correctness of our theory is also absolutely confirmed in practice, as we find that in no case do we experience these troubles where a water is used containing practically the same amounts of the substances shown in the chart under consideration, other than the soda salts.

The next analysis shows a very interesting problem brought to the attention of the writer several years since:

ANALYSIS NO. 2.

Silica	1.576	Grains	Per	Gallon
Oxides of Iron and Alumina	.280	"	"	"
Carbonate of Lime (Chalk)	Trace	"	"	"
Sulphate of Lime (Gypsum)	44.989	"	"	"
Carbonate of Magnesia	11.339	"	"	"
Sulphate of Soda	2.404	"	"	"
Chloride of Soda (Common Salt)	4.590	"	"	"
Undetermined Matter	.096	"	"	"
Total	65.274	"	"	"

First let me call your attention to the fact that about 58 grains out of 65 are made up of scale forming salts, and about 45 out of the 58 are sulphate of lime. Naturally we would expect this water to give rise to the formation of a large amount of scale, and it did. Furthermore, we would expect the scale to be made up of sulphate of lime to a very large extent, which was also true as shown by analysis. Now the peculiar trouble in this case was serious corrosion underneath the scale. It is not uncommon for some to assume that if we have the surface of a boiler covered over with scale, corrosion would be practically impossible. In stationary practice it is a common expression that we would rather have 1/32" of scale over the interior

of the boiler than to take the chances of corrosion. This position must of necessity be considered erroneous. Upon a thorough investigation it was found that corrosion actually did take place and to a very serious extent, and this condition gave rise to greater anxiety than the scale formation itself.

Now to arrive at some rational explanation as to what actually did take place. Upon a careful analysis of a portion of the scale lying next to the metal, which was apparently originally a part of the surface of the metal, it was found that there was an action going on which compared identically with the action of sulphuric acid upon iron, because sulphate of iron was found on analysis of the substance taken off of both the surface of the tube and the side of the scale which was originally in contact with the tube. The water itself was not acid, contained no free sulphuric acid, and consequently must be a liberated product. The theory advanced as a result of the investigation thus far carried on was that the sulphate of lime constituting the greater part of the scale lying in direct contact with the metal did reach a temperature, when the scale had become of sufficient thickness, which caused a decomposition of the sulphate of lime, liberating sulphuric acid. This sulphuric acid in turn attacked the metallic iron, giving rise to corrosion. The sulphate of iron formed as the result of the corrosion, being an extremely unstable salt, that is, one that does not stay together very readily, breaks down in the presence of temperature and moisture, and again liberates sulphuric acid, leaving behind the iron in the form of iron oxide. The sulphuric acid again acts upon the metallic iron, producing more sulphate of iron, which is in turn converted into oxide of iron.

You might ask why the sulphuric acid leaves the oxide of iron to go to the metallic iron. In chemistry it is more true that every individual substance has an affinity, than it is in the human family, and the metallic iron has a greater affinity for the sulphuric acid than does the oxide of iron which it left, consequently we have the formation of a new portion of sulphate of iron. This is what the chemist would term a cyclic or continuous action, that is, the acid liberated from the scale, acting on the metallic iron, decomposing, acting again and again on the iron, and resulting in corrosion. How did we proceed to prove that this theory was correct? In order to bring about

decomposition we know that it was necessary to have temperature, because we know that sulphate of lime does not decompose below a certain temperature; so that with the use of mechanical devices the scale formation in this boiler in which the experiment was carried on was turbined down to one-half its original thickness, and it was found that as long as the scale was kept down to one-half the thickness which it ordinarily formed in a given length of time, no corrosion underneath the scale formation took place. Isn't that sufficiently strong evidence that the cause of the trouble was first due to a liberation of sulphuric acid, in turn due to the high temperature governing at the point of contact of the scale with the surface of the metal, which primarily was due to the thickness of the scale? Therefore with the prevention of scale formation to a great extent, we keep the temperature down at the point of contact, and obviate the liberation of sulphuric acid, and consequently eliminate the corrosion in this case. The correctness of the foregoing conclusions was confirmed by following out such procedure in practice.

ANALYSIS NO. 3.

Silica	.595	Grains	Per	Gallon
Oxides of Iron and Alumina	.116	"	"	"
Carbonate of Lime (Chalk)	8.783	"	"	"
Carbonate of Magnesia	4.569	"	"	"
Sulphate of Soda	1.836	"	"	"
Chloride of Soda (Common Salt) .	3.040	"	"	"
Undetermined Matter	.088	"	"	"
Total	19.027	"	"	"

In this water we have an illustration of the correctness of the statement made, that foaming can be due to suspended matter. I do not mean now that it is always attributable to that, as waters absolutely devoid of suspended matter, containing other substances, do foam without question. In this case we have a water that contains 19 grains of solid matter, of which all but about 5 grains are what could be classed as scale forming substances. As a matter of fact this water does not

under many conditions give rise to more than a small amount of scale formation. The carbonates of lime and magnesia when precipitated from a water of this type go out of solution in a very finely divided, oozy, or what might be termed a gelatinous condition, in which form they are not to a very great extent retained in a heater, but pass therefrom to the boiler in the form of suspended matter, where, due to their light gravity, they travel very readily with the circulating water. The small particles of these incrusting substances soon begin to generate steam from their own surfaces, which results in the body of water in the boiler assuming the condition of a seething mass, which finally results in a foaming condition. In other waters containing these same substances in virtually the same quantities, and also containing even a moderate amount of sulphate of lime, foaming is not usually experienced, owing, no doubt, to the fact that the sulphate of lime when thrown out of solution is much heavier than the carbonate of lime, and readily settles upon the interior surfaces of the boiler, and in so doing carries with it mechanically a considerable part of the precipitated carbonates, the mixture readily attaching itself to the surface of the boiler in the form of incrustation.

An experiment was carried on for the purpose of determining whether or not the foaming experienced in this case was correctly attributable to the precipitated carbonates, as follows: the feed water was treated in such a manner as to remove about one-half of the carbonates of lime and magnesia shown by analysis No. 3, and then pumped into the boiler, and it was found that it was possible to operate the boilers over a period of sixty days, with no trouble in the form of foaming. Further experiment developed the fact that the same results could be obtained by changing the carbonates into other substances by chemical reactions, and at a much lower cost.

There is another condition that arises from the use of waters of this kind. Since the carbonate of lime is thrown out of solution in a very finely-divided and light condition, and gives rise to trouble in the form of foaming and priming, we may correctly assume that the steam space in these boilers is full of these floating particles, in which condition they would naturally carry over with the steam. It is commonplace in districts where waters of this kind are used to have complaints to the

effect that it becomes necessary to open up the cylinders of the engines every so often, in order to remove more or less of a black, putty-like substance. Upon analysis of many samples, we found that this so-called putty-like substance was nothing but a mixture of cylinder oil and carbonates of lime and magnesia, principally the former. We know that the oil itself carries none of these substances, consequently there is no other possible way of its coming into the cylinders except that it be carried over mechanically with the steam, and that is just what happens. Even though there is no foaming or priming, the finely-divided carbonates of lime and magnesia carry over and are constantly rubbed together with the cylinder or valve oil, and produce this putty. This trouble was overcome also by changing the nature of the precipitated substances by chemical reaction.

ANALYSIS NO. 4.

Silica	28.382	Grains	Per	Gallon
Oxides of Iron and Alumina	3.760	"	"	"
Carbonate of Lime (Chalk)	.398	"	"	"
Sulphate of Lime (Gypsum)	1.879	"	"	"
Carbonate of Magnesia	.372	"	"	"
Sulphate of Soda	Trace	"	"	"
Chloride of Soda (Common Salt)	.850	"	"	"
Undetermined Matter	.216	"	"	"
Total Soluble Mineral Solids	35.857	"	"	"
Suspended Matter	113.413	"	"	"

This analysis I must show you, as it is a curiosity. Based upon a knowledge of upwards of 150,000 analyses covering that many different waters, I will say this is the only one of its kind that I ever came in contact with. I have already told you that silica is ordinary sea sand. You will notice that the total amount of solids in this water in solution is 35.8, of which 28 grains is silica. You would hardly realize that 28 grains per gallon, or four pounds per thousand gallons, of ordinary sea sand would go into solution. But we positively know that in this case it is in solution. When you recall the part that silica plays

in the enamels on your bath tubs, you can realize the tenacity with which it adheres to metallic surfaces. But you may say that in the case of the bath tub it is put on under high temperature. That is true, but they use silica in an entirely different form for that purpose. Here we have silica in a gelatinous form, the fusing point of which is very much below that of the silica in the form used in the enamels, and as a matter of fact the boiler in which this was used was coated with an enamel just like the enamel on the bath tub, except that it was brown in color, due to the iron oxide it contained.

This analysis brings to mind another point that I believe it is well to mention here. As a chemist who is meeting people and discussing the analysis of water every day, it is not uncommon to hear the question asked, "Why not filter it?" even though the water in question was perfectly clear and therefore contained no suspended matter. You will notice that while this water carries but 35.8 grains of matter in solution, it carries 113 grains in suspension. All of the 113 grains were removed by filtration before proceeding with the analysis or determination of the kinds and quantities of substances contained in solution. This confirms the statement previously made, to the effect that the 28 grains of silica was actually in solution, and right here let me impress this fact upon you, that you cannot remove from a water by any method of filtration, anything that is contained in *solution,* except that you treat the water with chemicals before hand and convert some or all of these substances into an insoluble form, in which form they go out of solution and then constitute suspended matter. You cannot remove from a water by the ordinary method of filtration without chemical treatment anything that you cannot see with the naked eye, barring bacteria which may be removed by some of the so-called bacterial filters, but they are not supposed to be considered in connection with water for technical purposes.

ANALYSIS NO. 5.

Silica	.525	Grains Per Gallon
Oxides of Iron and Alumina	.093	" " "
Carbonate of Lime (Chalk)	.222	" " "
Sulphate of Lime (Gypsum)	5.273	" " "
Carbonate of Magnesia	5.388	" " "

Chloride of Magnesia	5.151	Grains	Per	Gallon
Sulphate of Soda	Trace	"	"	"
Chloride of Soda (Common Salt) .	8.790	"	"	"
Undetermined Matter	.065	"	"	"
Total Soluble Mineral Solids .	25.507	"	"	"

ANALYSIS NO. 6.

Silica	1.168	"	"	"
Oxides of Iron and Alumina	.105	"	"	"
Carbonate of Lime (Chalk)	5.559	"	"	"
Sulphate of Lime (Gypsum)	3.786	"	"	"
Carbonate of Magnesia	3.021	"	"	"
Chloride of Magnesia	2.731	"	"	"
Sulphate of Soda	Trace	"	"	"
Chloride of Soda (Common Salt) . .	5.723	"	"	"
Undetermined Matter	.145	"	"	"
Total Soluble Mineral Solids .	22.238	"	"	"

These two analysis (Nos. 5 and 6) are of interest for the reason that they confirm the contention that the ill effects of a water are not exclusively attributable to the quantities or kinds of subsances contained, but usually more particularly to the relative amounts of these substances contained. The water as per analysis No. 5 naturally gave rise to scale formation in considerable quantities, but the most objectionable feature was that of corrosion. This water was and is now being used in locomotive service, and it is a well known fact that the flue sheets corrode so rapidly that it is seldom possible to operate a machine more than six months without replacing them. The most serious corrosion in this case took place principally above the water line. Why? You will notice that the water carries a trifle over 5 grains of chloride of magnesia and virtually one-fourth grain of carbonate of lime. Chloride of magnesia under a temperature of even 250° Fahr. decomposes and liberates hydrochloric or muriatic acid. We further know that muriatic acid is volatile and carries with the steam, and we also know that muriatic acid when in even very dilute solution readily attacks iron. All these facts then strongly confirm the conclusion that the

corrosion which took place could correctly be traced back to the chloride of magnesia in the feed water.

It was found upon further careful investigation that steam and moisture taken out of the boiler at a point well above the water line had a decided acid reaction, and we positively proved that acid to be muriatic, and consequently a product of the decompesition of chloride of magnesia, which constitutes further evidence of the correctness of this theory.

Referring to analysis No. 6, here we have another water that carries chloride of magnesia, but it gave rise to no corrosion, practically speaking. Why? It is a well known fact that if we have carbonate of lime present in a water to a sufficient extent, along with the chloride of magnesia, it will combine with the muriatic acid liberated, and neutralize it, producing chloride of lime, and in this way prevent the corrosion by the muriatic acid, which would otherwise take place.

In the case of the water as per analysis No. 5, we had present a little over five grains of chloride of magnesia and only approximately one-fourth grain of carbonate of lime, while in the case of the water as per analysis No. 6 we have five grains of carbonate of lime and but two and three fourths grains of chloride of magnesia, which means that in the former case the ill effects of the acid were not offset by another substance contained in the water, while in the latter one they were. You will see from this, that the action of a water in a steam boiler is not always dependent upon the total amount of substances contained, nor the kind contained, but more likely in most cases upon the relative amounts of the different substances present.

ANALYSIS NO. 7.

Silica	.310	Grains	Per	Gallon
Oxides of Iron and Alumina	.081	"	"	"
Carbonate of Lime (Chalk)	None	"	"	"
Sulphate of Lime (Gypsum)	.380	"	"	"
Carbonate of Magnesia	Trace	"	"	"
Chloride of Magnesia	.258	"	"	"
Sulphate of Soda	.261	"	"	"
Chloride of Soda (Common Salt)	.533	"	"	"
Undetermined Matter	.046	"	"	"
Total	1.869	"	"	"

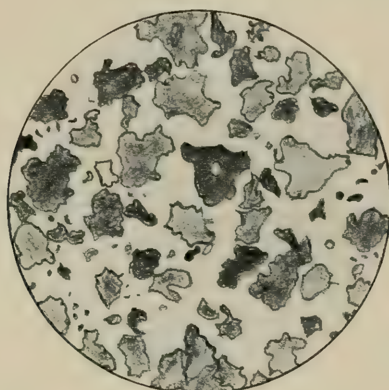
Here is a water that has been passed on by chemists many times, and pronounced an ideal water for boiler purposes. It contains, as you will note, but 1.8 grains of total solid matter. Let us see how much of an ideal water it is. I have here a nipple (exhibiting nipple showing excessive corrosion in the form of pitting, several pits perforating the specimen completely) taken from the cold water side of a feed water system in a stationary plant, which had been in service less than six months. As a matter of fact, for a number of years it was found necessary in practice to replace the cold water portion of this system once in every six or seven months; and with all this going on in this part of the system, no corrosion took place in the boiler. Since nothing was passing through this portion of the system, but the cold water, and with a further knowledge that water under many conditions will dissolve more or less of all metals such as gold, silver, lead and iron, and under most conditions will dissolve more iron than of other metals, we can for the sake of the first step in the investigation assume that it could be correctly attributable, at least to a considerable extent, to the water itself.

With this in view, an investigation was carried on as follows: four samples of water were taken from the following points; viz., original source of supply, near the inlet to the pipe system, near the outlet of the system, and from the pet cock at the bottom of water column. Very careful determinations of the quantity of iron (in solution) were made and it was found that the amount of iron contained in sample from near inlet corresponded with that contained in sample from original source, but in sample from near outlet two and one-half times as much iron was found. These figures represent the amount of iron actually in solution, and do not include any which might have been in suspension, therefore show conclusively that the water did actually dissolve or take up iron in passing through the pipe system. In the case of the sample from the boiler, there was found a large amount of iron rust in suspension, but the same amount in solution as was found in sample taken from near outlet of cold water system. The amount of iron *in solution* in sample from boiler is certain and positive proof that in passing through the pipe in question, the water had taken up as much iron as it could hold in solution, or in other words was

saturated and it could not dissolve any more after leaving the point in the pipe system at which it had become saturated, consequently could not and did not exert a corrosive action in the boilers.

But, you say to yourselves, if this is a solvent action, why did it not take place uniformily over the entire surface, rather than in the form of pitting? Let us see. If we take a piece of boiler plate and bring it to a high state of polish, and put it under a high power microscope, we see something that might look like this:

Figure No. 20.



This illustration is evidence that the composition of iron or steel is not continuous or uniform. No doubt many of you at least have had the opportunity to look over a chemist's report covering a sample of iron or steel; in case you have you must have noticed that he did not state the amount of iron it contained, but he did tell you that it contained carbon, silicon, maganese, sulphur, phosphorus, etc. Each and every one of these substances, as they exist in the metal of the sheets or tubes, are chemically combined with a certain amount of the pure metallic iron or other metals, forming new substances characteristic of themselves, which are very different from the pure or uncombined iron itself. The balance of the metal is made up of uncombined iron, commonly known as ferrite. Since, then, the sheets or tubes are not of continuous or uniform composition, and knowing that practically no two different substances are soluble to the same extent, we can assume that the com-

pounds of iron which were the most soluble in the water in contact with their surface would first of all dissolve to the greatest extent, which would result in the corrosion showing in the form of pitting rather than taking place to a uniform extent over the entire surface.

We are now leading up to some of the more modern theories governing the corrosion of iron and steel, which must of necessity have a direct and important bearing upon that which takes place in steam boilers. I might simply state here, that there have been three principal theories advanced during the past several years, generally referred to as the electrolytic or galvanic, the carbonic acid, and the peroxide theory. Since, however, the electrolytic theory has virtually displaced the other two, it is the only one which we will consider at this time, and it only in a meager manner, but even thus I feel that some discussion of it will make the cause of trouble in the form of corrosion more comprehensible to you.

Science tell us that every substance in existence is either electro-negative or electro-positive to every other substance. We also know that it is not uncommon in boiler practice to have present a noticeable galvanic current, which, if this theory is correct, must result in corrosion. There are three essentials to a galvanic cell, viz., an electro-positive, an electro-negative substance or pole, and an electrolyte or carrier. As shown heretofore when referring to the non-continuity of iron or steel (see figure No. 20) we have, even in a small area of sheet or flue, the necessary different substances to act as the two poles, and the presence of a layer of water over the surface will act as the carrier. Therefore we have the necessary elements for corrosion. If the water carries more or less common salt, or some other substances, the current-carrying capacity of the water is enhanced and the tendency to corrosion relatively increased.

We must not for a moment lose sight of the fact that with a properly equipped locomotive the boilers are directly connected with brass fittings, copper ferrules and at times other metallic accessories, to say nothing of the difference in the character of many flues, or the flues and shell, or both, all of which tend to corrosion in some form or another. We may have either wrought-iron or steel flues or tubes in a boiler, which may be

absolutely as good as it is possible to produce, but sufficiently different in their composition or continuity, or both, to bring about a possible condition leading up to electrolysis.

Since as previously stated there are three essentials to an electrolytic action, it stands to reason that if we can eliminate one of these the trouble would be overcome. It is not, however, possible for us to prevent two substances acting in the capacity of the two poles of a battery, under favorable conditions, but it is possible to so change the water being used as a feed supply as to destroy its ability to act as an electrolyte, and thereby prevent corrosion.

I have with me and will exhibit several lantern slides which I believe will enable me to bring out to a better advantage further comments upon the electrolytic theory of corrosion; but before showing them I desire to call your attention to a few results of an investigation having a bearing upon this subject, which was carried on by one Farquharson, in 1882, with six iron and six steel plates. These pieces were submitted to the action of sea water for a period of six months, three each of the iron and steel plates separately, and the other six as connected couples. In this way he could note the comparative corrosion of the iron and steel when exposed separately to the corrosive effect of the water, as well as any increase in the corrosion due to galvanic action taking place between the iron and steel, as shown by the two plates constituting the couples (iron and steel in contact).

The following table shows the results obtained:

			Loss
Iron)		(Iron	427 Grs.
)	In contact	(	
Steel)		(Steel	7 Ozs. 417 Grs.
Iron)		(Iron	3 " 340 "
)	Separate	(	
Steel)		(Steel	3 " 327 "
Iron)		(Iron	2 " 337 "
)	In contact	(	
Steel)		(Steel	6 " 000 "

Iron)		(Iron	4 Ozs. 157 Grs.
)	Separate	(	
Steel)		(Steel	4 " 570 "

The above constitute the results in four out of six experiments reported. You will notice that in each case where the iron and steel were exposed separately, the loss was practically the same, while in case of the couples (iron and steel in contact) there was a very great difference, the steel losing by far the greatest amount. From this you must not infer that either of the metals used were of inferior quality, but that the difference in loss was attributable to the difference in the character of the two.

As a matter of further interest along these lines, I desire to call your attention to the results of one more investigation, carried on by another eminent authority, showing the relative corrosion of iron when submitted to the action of sea water and in contact with other metals and alloys, the metals and alloys being electro-negative to the iron. All specimens and couples were exposed to the action of the water the same length of time. The following table shows results obtained:

	Relative Corrosion.
Iron Plate alone	Lost 8.63% of its own weight
Iron Plate in contact with Brass	Lost 29.64% of its own weight
Iron Plate in contact with Copper	Lost 42.79% of its own weight
Iron Plate in contact with Lead	Lost 47.90% of its own weight
Iron Plate in contact with Gunmetal	Lost 56.39% of its own weight
Iron Plate in contact with Tin	Lost 74.71% of its own weight

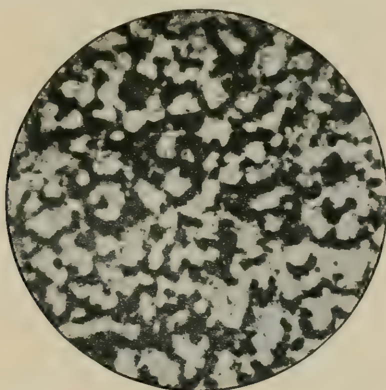
While the above two tables show the action due to sea water, which we are aware is very bad in so far as its corrosive tendencies are concerned, it is also true that a large number of waters available for use as boiler feed supplies carry tendencies to the same trouble, but relatively to a less extent, as the amount of substances contained are less. We also in a large number of cases find in a water of fairly good quality (so far as the quantity of the substances contained are concerned) virtually the same kinds of substances as are present in sea water, and in such a case you must not overlook the fact that

the water or solution remaining in the boiler is very rapidly concentrating, resulting in it becoming very much like the sea water, and under such conditions the results must be similar in character and extent.

I will now proceed with the slides, if I may have them thrown upon the screen.

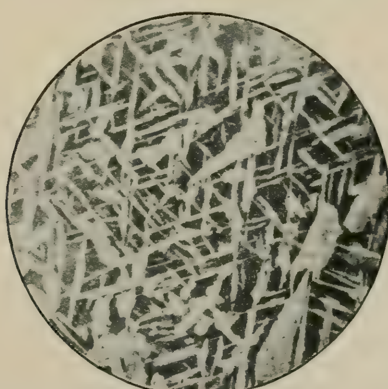
The first three slides which I will show you will no doubt make more plain what has been said regarding the continuity of iron and steel.

(Slide No. 1)



This slide shows a microphotograph of Bailey Converter steel. You will notice particularly the structure shown, and keep this picture in mind while the next two slides are being shown.

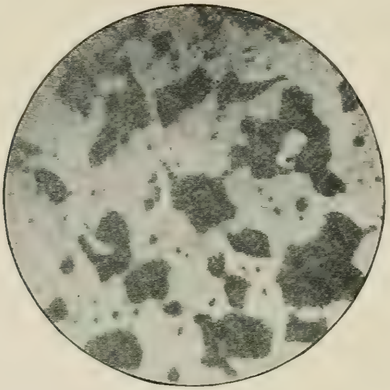
(Slide No. 2)



This one shows also a microphotograph of open hearth

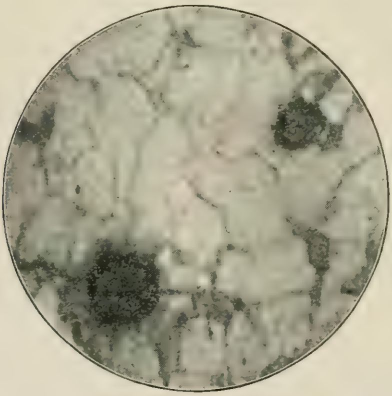
steel, unannealed, quite different in structure from the one previously shown, isn't it?

(Slide No. 3)



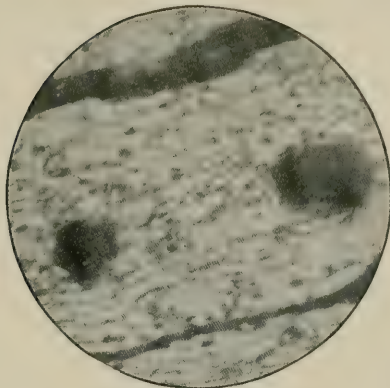
Here we have one showing the structure of Bessemer Steel.

(Slide No. 4)



This slide shows a condition which is not uncommon, even though no expense is spared, and every precaution taken to obviate it. It shows the presence of slag, the dark spots being small particles of slag which have become imbedded in the metal during process of manufacture. This slag is of entirely different composition from the metal, and has also a very different solubility in water. Since the difference in potential between the slag and metal is very great, its presence very greatly increases the possibilities of corrosion.

(Slide No. 5)



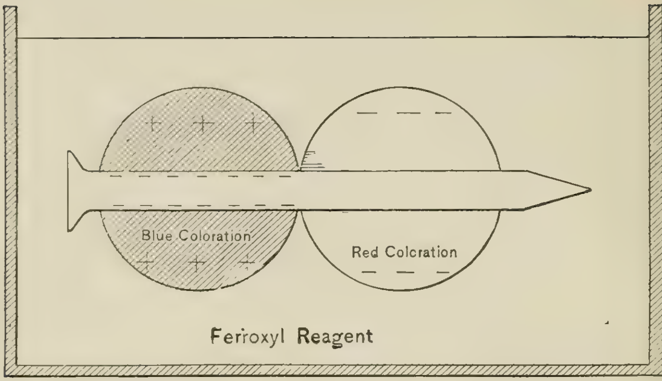
This slide shows a condition similar to the one previously shown; however, the dark spots and streaks show the presence of oxides of iron, which are very active in increasing the rapidity with which corrosion will go on; e. g., one authority (whose name I cannot just now recall) in referring to the effect of the presence of iron oxide, has substantiated this statement in the results obtained from an experiment, carried on as follows:

Two pieces of steel plate were thoroughly cleaned and polished, and one of them submitted for twenty-four hours to conditions favorable to corrosion. The other piece was submitted for the same length of time to conditions under which corrosion would not take place. The two pieces were then brought together and the difference in their electrical potential determined, and it was found to be .104 volts.

The next few slides that will be shown will illustrate to a very meager extent some of the experiments that have in the past been carried on in connection with the study of the corrosion of iron and steel. The experiments to be referred to were carried on some years since, and the methods for so doing were devised and furnished by Allerton S. Cushman, then connected with the Bureau of Good Roads, Department of Agriculture of the United States.

(Slide No. 6)

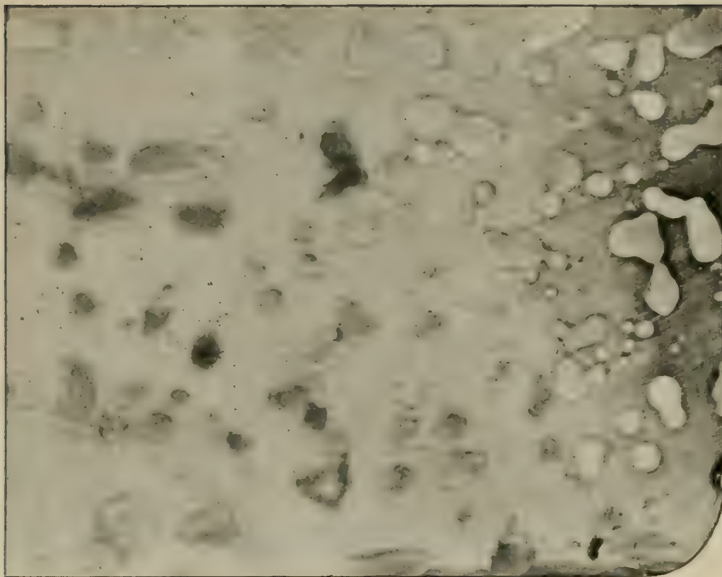
This slide is shown more particularly to furnish me with an opportunity to explain the fundamentals underlying the experiments to be illustrated with the following slides. You



will note at the bottom the name "Ferroxyl Reagent." This has reference to a medium or reagent made up in such a manner as to enable us to cover the surfaces of specimens of metals of different kinds, either by allowing the reagent when warm to flow over the surface of the metal, or by immersing the metal completely in the reagent, and allowing it to cool, when the reagent solidifies. In this reagent is incorporated two indicators: one which when subjected to the negative area turns pink (shown as light grey circle in illustration No. 6), the other giving a bluish green color in the presence of iron in solution (showing black in illustration No. 6). In this case we have supposedly immersed an ordinary nail, one of the circular areas shown becoming pink, which means negative polarity, and the other blue, showing positively that iron has gone into solution and consequently is of positive polarity. Since in all corrosion of iron the metal must undoubtedly first go into solution, and since the positive pole is always the one destroyed, we must be rather positive of the conclusions arrived at.

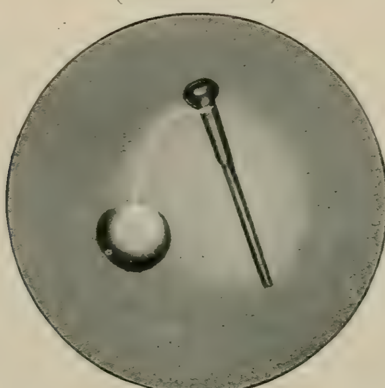
(Slide No. 7)

We have in this illustration a piece of boiler plate which was first thoroughly cleaned, and finally brought to as high a polish as was possible by ordinary methods. The surface of this plate was then covered with the Ferroxyl Reagent and allowed to stand at rest. Within a very short time the condition shown by the picture upon the screen was evident. The darker spots shown in this cut correspond to the positive areas as developed, as in the actual experiment they became blue or bluish-green in



color, showing that iron at these points was going into solution. The lighter portion of the entire area in the actual experiment assumed the pink color, which is proof of the fact that this portion of the surface of the plate had assumed a negative condition. Thus we have the positive and negative poles necessary to electrolysis. All that is further essential is the presence of a substance which would act as an electrolyte or carrier of the current from one pole to the other; therefore, as soon as the plate is covered with water or moisture, we have this third essential supplied, which is the case here, as distilled water constitutes a large portion of the reagent itself.

(Slide No. 8)

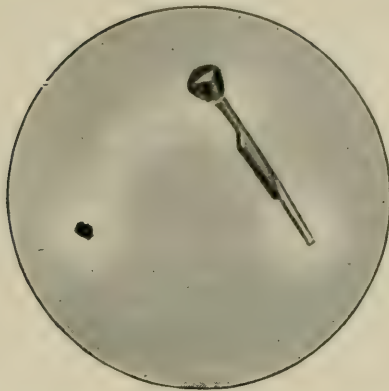


In this case we have an ordinary steel nail connected up with what was originally a piece of metallic zinc, the white spot in the cut showing the location of the zinc, the darker area showing that part of the steel nail which had later assumed a positive polarity. The metallic zine, so long as it was present as such, acted as the positive pole in the couple, as it would be expected to do because of its being electro-positive to the other metals present. This would account for the pink or negative area shown in the cut surrounding the entire body of the nail except the head. When the positive pole (zinc) had become entirely destroyed, or in other words converted into the oxide of zinc, it ceased to maintain this polarity, which therefore shifted, the head of the nail becoming positive, which resulted in a going into solution of more or less of the iron, as shown by the dark area surrounding same.

(Slide No. 9)

In this case we have another ordinary steel nail connected up with a piece of metallic copper. Before the plate from which this photograph was taken had stood very long, the reaction had developed sufficiently to show the small piece of copper and the platinum wire connecting the two, only as possessed of negative polarity, the dark area surrounding the body of the nail constituting the positive area. The negative area shown at the two ends of the nail were secondary developments, showing that a sufficient change had taken place to cause the two ends to become negative as against the middle portion positive.

(Slide No. 10)



You will recall some statements previously made, pertaining to the increased rapidity of corrosion in the presence of oxides of iron; for example, iron rust. In this picture we have a piece of ordinary iron rust connected up with another steel nail. In the early part of the life of this specimen, the area surrounding the small piece of iron rust only assumed the negative condition, while the head of the nail assumed a very strong positive condition, which resulted in the corrosion of the head to the extent shown, as per dark area in cut representing this slide. At first no negative indications were shown around any portion of the nail itself, but after the corrosion had taken place on the head of the nail to practically the extent shown, the point of the nail and an area corresponding to a small part of its length between its head and its center, assumed a negative position. The most interesting fact in connection with this slide is that the picture showed these effects during the short period of not more than one hour.

(Mr. Converse at this point with the use of the lantern showed many views of their offices, laboratories and manufacturing plant.)

It has been my endeavor this evening to at least furnish some matters for your serious consideration and to possibly make more plain to you the cause and effect of some boiler troubles. In conclusion, I desire to thank you very cordially for your good attendance and very kind attention.

PRESIDENT MITCHELL: Gentlemen, if you have any questions to ask, Mr. Converse will be glad to answer them.

MR. W. J. MURPHY: I wish the speaker would tell us why it is that the deterioration of metal takes place on the water side of the fire box sheets at the rivet seams and around stay-bolts, and does not have any action at all on the water side of the outside or wrapper sheet of locomotive boilers. Is the deterioration on the locomotive boiler sheets, above the water line, something out of the ordinary?

MR. CONVERSE: In answer to your first question will say that the area of the sheet at or very near the staybolts and rivet seams has during the process of construction of the boiler been submitted to a strain or stress, to which the other portion has not, resulting in a changed condition of the strained portion, which would in the first place increase the possibility of corrosion at this point; and again, while the boiler is in operation the fire box sheet is being submitted continuously to conditions resulting in gradual and further change in the metal. These conditions are brought about, due to change in temperature in fire box as a result of opening of fire box door, and also to the difference between the temperature in the fire box and the water on the inside of the boiler, and to the fact that the temperature in the fire box is several hundred degrees higher than that of the water. The physical character of iron or steel is always changed when submitted to variable strains or stress, which means greater non-continuity, which in turn means greater possibility of corrosion. I am of the opinion that the process of making the rivet holes by punching instead of by drilling, as formerly was the case, has materially increased the possibility of corrosion at this point.

As to the deterioration of boiler sheets above the water line, would advise that this is not so common in boilers in locomotive service as in those in stationary service, but it is not at all uncommon. Where the water or waters used contain an amount of chloride of magnesia relatively high as compared with the carbonate of lime, or where they are impregnated with considerable ammonia, such trouble invariably takes place.

MR. W. H. RITTS: I would like to ask why it is that when you remove some of the old tubes from a boiler and replace them with new tubes, the new tubes will pit and groove

and the old tubes will not be affected? Would you attribute that to the water?

MR. CONVERSE: In my opinion that is directly attributable to the electrolytic or galvanic action which we have had under consideration. If, for example, the old tubes which have been in use for some time had had removed from their surface the mill scale (oxide of iron) present, there would exist a sufficient difference in electrical potential to give rise to corrosion. Of course, it would be necessary to have present the electrolyte or carrier, and the water contained in the boiler would act as such. The rapidity with which the reaction would go on would be dependent upon the capacity of the water to carry current, which would be influenced by the kinds and quantities of substances contained in the water. Of course, in such cases as these I am assuming tht we are using water or waters containing no substances which would literally dissolve the metal, such as sulphuric or other mineral acids.

MR. RITTS: Some types of boilers have baffle plates where the feed water enters the boiler and stops the water from circulating. It will attack the boiler plate, also the baffle plate, at the point where feed water is discharged into the boiler. In some of these types, it grooves or pits. If you remove the baffle plate, this action will stop. Do you not think the CO_2 will concentrate at this point?

MR. CONVERSE: According to the more modern ideas of the causes of corrosion, carbon dioxide (CO_2) is not considered as active a corrosive agent as it at one time was, and from results in practice we can hardly attribute this effect to such gas. Since we know that the same kind of water enters the boiler during the absence of the bafile plate and in the same quantity, we must assume that the same amount of CO_2 also enters the boiler during a corresponding length of time. This being the case, if CO_2 was particularly corrosive in its action, we would expect to find in the boiler, without the baffle plate, evidence of corrosion, at least in some locality. If on the other hand the character of the metal constituting the baffle was different from that of the boiler plate, there would be present favorable conditions for the trouble cited.

In order to further explain the action, both on baffle and

plate, we must reason that one or the other at the beginning was acting in the capacity of the positive pole (which is always the one where the destruction takes place), upon which corrosion took place, until at least a considerable part of the surface was changed to oxides of iron, in which condition it could assume a negative position, when the action would transfer itself to the surface of the other. Under the conditions to which the surfaces referred to were submitted, no doubt a considerable erosion or wear took place, due to the impinging of the incoming feed water. From the above, it can hardly be concluded that the corrosion was due to a concentration of CO_2 in the locality where the trouble took place.

MR. RITTS: I cannot understand why removing the plate would stop this action on the boiler sheet.

MR. CONVERSE: Because in removing the plate you removed a substance which possibly was very different in electro potential from the balance of the boiler. It is, however, also possible that due to the temperature to which the water is suddenly raised as it enters the boiler, some of the substances contained, when brought so closely in contact with the iron, are changed sufficiently to give rise to corrosive substances. A consideration of the theories governing such changes as could take place cannot be attempted now, on account of time required. In the absence of the baffle plate, no doubt there would also be a much more general distribution of any deleterious substances, which would result in much less localizing an action of this kind.

MR. RITTS: There are a number of things to show that there must be an erosion the same as if sand would flow over the surface. Take a return tubular boiler after the tubes have been removed from an old boiler, so that you can see the sheets and rivets. Along the bottom of the boiler on the inside, it will be worn away and cut out just like rain water will cut the shingles on a shingle roof. Is this the acid, or what do you attribute this action to?

MR. CONVERSE: In my estimation that is an effect of erosion due to the circulating particles of sand or mineral matter which constantly whip around with the water, resulting in a wearing away of the metal. There might be some other condition that we do not now know of, such as the composition of

the water or the rivets, that might intensify the result, but I am of the opinion that a thorough investigation would show that it was due to a greater extent to the mineral substances in the water in suspension being carried mechanically with the circulation, and impinging upon the affected surfaces.

MR. RITTS: You can treat the water and it will stop this action.

MR. CONVERSE: The extent to which erosion due to the substances present in the water in suspension could be overcome would be dependent upon the character of the suspended substances. Some of them could be readily changed by chemical reaction, so as to cause them to be distributed uniformly through the body of the water and not remain on the bottom of the boiler in such close contact with the metal; but others, for example, sand, could not. The better way to keep out of this trouble would be to keep the quantity of mud down to a minimum, by proper blowing and washing of the boilers.

MR. C. A. LINDSTROM: Mr. Converse has said a great deal about what takes place in boilers, but he has not given a hint as to how these evils may be cured. I do not suppose there is a compound that would cure it in every case, but that it would be necessary to submit samples of water before a remedy could be recommended.

MR. CONVERSE: That is it exactly. There is no one substance or preparation known, that can be correctly classed as a specific, or that can cure all kinds of troubles, even when confined to a very limited territory. I want to say just here that my mission this evening is not to specially boost our products or criticise anybody else's, but to endeavor to convey, if possible, to all of you, at least some information which some time may prove of value to you. We cannot rationally assume that waters from the different sources, even in a small district, are at all the same in character, and an endeavor to furnish a satisfactory remedy on such an assumption would be about the same as your family physician prescribing for a member of your family without seeing the patient.

MR. R. E. WAGGONER: May I ask about water softening plants on the Allegheny River?

MR. CONVERSE: I do not know that I can recall exactly

the analysis of Allegheny river water, but as I remember it I would say in a general way that I would not use them. I suppose I shall be criticised for saying that. I will ask Mr. Waggoner if water from this river is similar in character to that from Monongahela River? Does it ever run acid?

MR. WAGGONER: No, it is hard. About 7 grains.

MR. CONVERSE: In a water to be softened we will assume that you have 7 grains of incrusting salts. The lowest possible quantity to which you can reduce them is 4½ to 5 grains per gallon. Is it going to pay you to put several thousand dollars in a plant to remove 2½ grains of incrusting matter? No, providing you can arrange to take care of those substances in some other way. The important part of water softening is this, that it is just as essential that that method be correctly applied to the proper water, as any other method. Generally speaking, if a water is sufficiently impregnated with incrusting solids or sufficiently hard to warrant the expenditure incurred in a water softening plant, it is almost invariably essential to use a suitable treatment with the softened water, to counteract the ill effects of the softened water itself, because for every pound of sulphate of lime contained in 1000 gallons of water you leave in solution as a result of the softening process a little more than a pound of sulphate of soda. So that when a water is hard enough to be a practical water softening problem, there is bound to be foaming or corrosion, or troubles of that sort, with the treated water. Take a water like that of Lake Michigan, for example; there is absolutely nothing to be gained by a water softening method because you cannot take anything out of it except about ¼ to ½ grain of sulphate of lime.

MR. WAGGONER: When you have a water condition where the acid runs anywhere from 3 points to 9 points to the 1000 gallons, you have to use a certain amount of soda ash to neutralize the acid. When it gets up to that high point of acid, would the soda ash have the same effect on the boiler as the acid?

MR. CONVERSE: Oh no, because of this fact. When you add soda ash to neutralize the acid you produce a substance which we know as sulphate of soda. A solution of sulphate of soda will not dissolve iron like a solution of sulphuric acid will.

It does, however, induce foaming and also an oozing out at the joints, and stimulates the carrying over into the cylinders of an excessive amount of moisture or water. Probably few of you appreciate what five grains of sulphuric acid per gallon of the feed water means; this amount is equivalent in round numbers to 3/4 pound per thousand gallons. Consider a boiler developing 100 horse power, which would mean an evaporation of approximately 9000 gallons of water every 24 hours, which would further mean that there would be present in the water remaining in the boiler 6 3/4 pounds of sulphuric acid, which would be very excessive, and at the end of a few days run the solution would be sufficiently strong to literally dissolve a part of the metal with which it came in contact. If you first neutralize the acid in the water, and would then place in it a piece of iron, the solution would not have the same solvent action. You might have greater corrosive action proper, but it would not be dissolving the metal as a whole and in so short a time. All the sulphates hydrolyze and give rise to an acid condition, but they do not dissolve metal bodily, acting rather as strictly corrosive agents.

MR. F. T. COPELAND: Where you have this pitting once started, is there any way of stopping it?

MR. CONVERSE: If you can destroy the electrolyte or change its character so that it will not act as such, then you destroy the electrolysis. Remember, three things are necessary for an electrolysis: two poles and an electrolyte. The moment you destroy one, whichever it may be, you destroy the possibility of an electrolysis.

MR. W. D. SMOOT: In case you use soda ash to neutralize acid in water, is it possible for the soda ash to be carried over with the steam and consequently affect your oil in lubrication?

MR. CONVERSE: That is very often found to be the case because of the fact that the greater the accumulation of these soda salts in the boiler the greater the tendency to wet steam, and wet steam means the carrying over of water with the steam. If we had a cylinder oil that was working along nicely with a dry steam and no provision was made therein for a wet steam, unquestionably it would affect your lubrication. The only

object in compounding a cylinder oil with an animal or vegetable oil is to better enable it to take care of this moisture. Mineral oils are better lubricants than vegetable or animal oils, unless we have moist surfaces, so the best practice is to mix just enough animal or vegetable oil of proper quality to cause the mineral oil to adhere to the wet surface. The wetter the steam the more we have to compound the oil, and a foaming condition in the boiler has a much greater effect on lubrication of a cylinder than many people imagine.

MR. D. J. REDDING: A locomotive was taken out of service, drained and set aside for eight months. It was found at the end of this period that the boiler was quite badly pitted. Another locomotive of the same type and condition, set aside and filled with water, showed no particular evidence of pitting in the boiler at the end of that period. Would you consider that experience unusual, or is it to be expected?

MR. CONVERSE: Rather to be expected. One-fifth of the atmosphere is oxygen and if your boiler is open and atmosphere circulating through it, you have a possibility of greater action, due to the greater amount of free oxygen in contact. There is another condition that might govern in this case, i. e., the permeation of the air in the empty boiler with sulphur gases always present in the atmosphere about power plants or shops where much coal is used as a fuel. These gases coming in contact with moisture are converted into sulphuric acid. If the boilers were thoroughly tight, and there was no possible chance for anything to get in, I would assume that the only action that would take place would be due to the oxygen contained in the air already in the boiler and the moisture that was left in it.

MR. REDDING: It frequently happens in locomotive service that you will set aside 15 or 20 locomotives for a time and the general practice is to drain the boilers. We have found in one or two cases that where that was done and sufficient time allowed to elapse, when we come to use them again they were pretty badly pitted and rusted. On the other hand, where these boilers were left full of water, there was no deterioration. In the case of a locomotive that only went into service occasionally, in the course of a couple of years we found that boiler in bad shape. When we built a new boiler for the same service and

adopted the practice of leaving it full of water that seemed to cure the trouble.

MR. CONVERSE: I have many times recommended to fill boilers rather than hold them empty. Even though you close them up as tight as possible, they are filled with air one-fifth of which is oxygen, and we know that iron or steel rusts much more rapidly when exposed to moist air.

MR. WAGGONER: May I ask the speaker if in his opinion boiler water treated with soda takes more heat units to boil than water in a raw condition. Would it be noticeable in a 4000 or 5000 h. p. plant?

MR. CONVERSE: No, I do not think it would. A substance only influences the boiling plant of water when it is in solution. If you soften water with lime and soda ash, you take out the sulphate of lime and put back virtually the same amount of sulphate of soda, which is a very soluble substance and causes a rapid concentration of the water in the boiler; and the greater the concentration the higher the boiling point. You must not lose sight of the fact that when you start to operate a boiler containing, say, 3000 gallons of water, each gallon of which contains five grains of the soluble salts, such as sulphate of soda, and you continue such operation, the amount of the soluble salts contained in solution in the water remaining in the boiler is increasing very rapidly and can go as high as upwards of 2000 grains per gallon. On account of the lesser solubility of the scale-forming salts, a large part of such as are carried into the boiler must go out of solution and assume, temporarily at least, the form of suspended matter, in which condition they could have no influence upon the boiling point of the water.

MR. WAGGONER: On Monday morning when we start in with raw Allegheny River water we always have 250 to 500 horse power to spare, owing to that condition. We changed to raw water for a whole week, and are running on fewer boilers than we did with treated water.

MR. CONVERSE: We often find very similar conditions where softened water is being used, and it can only be attributed to the increase in the quantity of the soluble salts due to the action of the chemicals used in softening. In most cases, however, the trouble is that of foaming, or at least very wet steam.

Outside water softening is purely a chemical process, and so far as the application of the chemicals is concerned, is usually placed in the hands of persons not chemists, who do not understand to a sufficient extent what they are trying to accomplish, which oft-times results in over-treatment, which in turn has the effect of increasing the quantity of the soluble salts, as well as the foaming tendencies.

MR. REDDING: That seems a very live question, the fact that the addition of soda ash or lime to treat the water increases the matter in suspension in that ratio and thereby takes more heat to generate steam. Is it possible to treat that water by some other method so that you will not get that accumulation?

MR. CONVERSE: Yes, to a certain extent. But it is impossible to annihilate matter, consequently all of the solid matter carried into the boiler must remain there, either in solution or suspension (in the form of mud), or in the form of scale proper, until time of washout and cleaning. It is not possible by treatment of the water to entirely prevent all accumulation so far as the so-called soluble salts are concerned, but it is possible, with the use of a proper treatment, to ward off at least to a very large extent all troubles due thereto. If you have a certain amount of solid matter in the water contained in a boiler, and add to it any amount of other soluble solid matter, you will have contained in the boiler a quantity corresponding to the sum of all, in one form or another.

MR. REDDING: Would it make any difference what you use, soda ash or Dearborn compound?

MR. CONVERSE: Yes. There are many things we use, that are not soda ash, in our preparations. We have no special formula. We are putting up well known, reliable remedies along intelligent lines, and the application thereof is based upon a knowledge that has been accumulated during an experience of upwards of thirty years. It is a question of knowing what you have to contend with and what you can best use to combat it. For instance, it would be possible instead of acting on the lime salts and having a soluble substance as a by-product, to convert that into a substance that is insoluble, and since insoluble substances in suspension will not raise the boiling point of the water,

and we would have no increase in the soluble salts, we can by getting rid of the mud obviate a rise in the boiling point.

MR. J. C. WARNE: Has the speaker had any experience in the application of graphite as a boiler compound?

MR. CONVERSE: Yes. When I say graphite, I mean graphite in general. It is a well-known substance; it is carbon in what we call a graphitic form. It is an absolutely well-known fact that there is no possible chemical reaction between graphite and any substance found in boiler feed waters. Any action that might possibly be brought about that might be considered beneficial would have to be of necessity mechanical. It is absolutely impossible for graphite to permeate through any formation in the way of scale of anything like ordinary density. You cannot force it through with a pressure of sixty pounds, I know. If you cannot force it through in that way, graphite will probably not permeate the scale in practice in the boiler.

There is this possibility. If you could get into the boiler and with a brush or otherwise put a polish on the interior of the boiler itself, like we do on a stove with stove polish, it would possibly smooth the surface of the metal and therefore prevent for awhile the adhesion of the particles of scale. But try to do that on a wet surface and you will find you are up against a very difficult job. And when applied to dry metal, graphite does not last long in contact with water. Consequently it cannot last long in a practical way.

PRESIDENT: The hour has come for closing.

MR. F. R. McFEATTERS: Before we adjourn, I believe this is one of the best talks and discussions we have had, and I would like to move that we extend to Mr. Converse a rising vote of thanks in appreciation of it.

The motion was duly seconded and carried by unanimous vote.

PRESIDENT MITCHELL: We now adjourn to meet in September, and I sincerely hope that when the time comes for the September meeting we will welcome our entire membership here.

ON MOTION, Adjourned at 10:57 P. M.

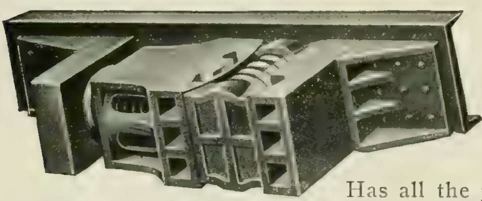
J. B. Anderson
Secretary.

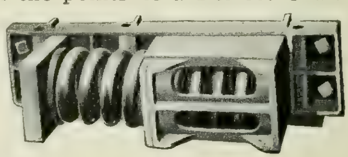
In Memoriam

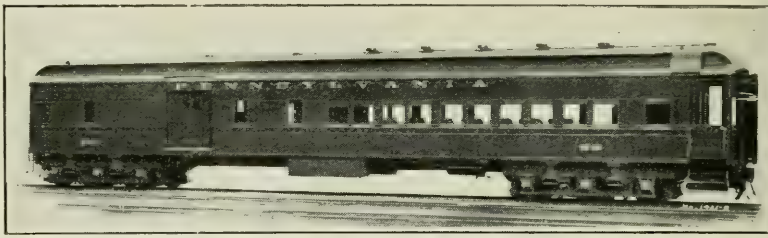
J. McC. BARWIS

DIED

MAY 20, 1914







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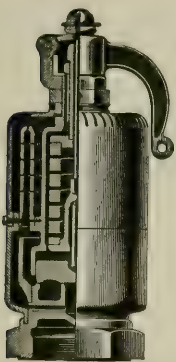
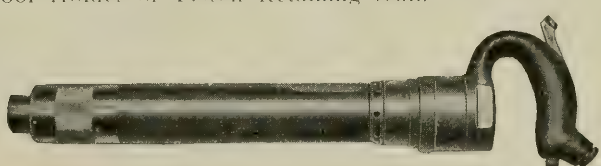
"Government Regulation of Railway Operation"

By Samuel O. Dunn, Editor Railway Age Gazette.





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OFFICIAL PROCEEDINGS
OF
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* H. W. WATTS..........................November, 1907, to April, 1908.
D. J. REDDING..........................November, 1908, to October, 1910.
F. R. McFEATTERS.......................November, 1910, to October, 1912.

* Deceased.

Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, SEPTEMBER 25, 1914.

The regular monthly meeting of the Club was called to order at the Monongahela House on Friday, September 25th, 1914, at 8 o'clock P. M., by President A. G. Mitchell.

The following persons registered:

MEMBERS.

Adams, Chas. F.
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Cooper, F. E.
Cooper, J. H.
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Clark, C. C.
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Craig, E. M.
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Deagen, J. J.
Detwiler, U. G.
Donovan, P. H.
Drayer, U. S.
Dudley, S. W.
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Dunlevy, J. H.
Emery, C. W.
Emery, E.
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Ferren, R. O.
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Fitzgerald, G. H.
Flaherty, P. J.
Fogle, E.
Frazier, E. L. Jr.
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Grieff, J. C.
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Harriman, H. A.
Haynes, J. E.
Heird, G. W.
Herrold, A. E.
Hink, G. L.
Hoffman, C. T.
Holt, Jas.
Howe, D. M.
Howe, H.
Huchel, H. G.
Hunter, J. A.
Hurley, Theo.
Jameson, Arthur A.
Johnson, W. A.
Kirk, T. S.
Knickerbocker, A. C.
Knox, Wm. J.
Koch, Felix
Krahmer, E. F.
Krimmell, H. E.
Lansbery, W. B.
Lindstrom, Chas. A.
Lindner, W. C.
Livingston, B. F.
Lobez, P. L.
Mason, Stephen C.
Middlesworth, G. E.
Mitchell, A. G.
Miller, F. L.

Miyasaki, Y.
Murphy, W. J.
McAbee, W. S.
McCollum, G. C.
McFarland, H. L.
McFeatters, F. R.
McGough, J. E.
McKeon, J. W.
McKinstry, C. H.
McNulty, F. M.
Neel, T. M.
Painter, Jos.
Parke, F. H.
Penn, Wm.
Phillis, W. A.
Pie, J. J.
Pratt, I. D.
Proven, John
Rabold, W. E.
Redding, D. J.
Ritts, W. H.
Robbins, F. S.
Ryan, W. F.
Sarver, G. E.
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Schultz, G. H.
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Shourek, T. L.
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Smoot, W. D.
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Schauer, A. J.
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Thomas, J. H.
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Warne, J. C.
White, F. L.
Williamson, J. A.
Wood, V. V.
Wyke, J. W.
Yon, H. C.

VISITORS.

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Bohamon, G. L.
Burket, C. W.
Curtis, C. A. Jr.
Dixon, D. J.
Dougherty, N. F.
Dunn, Samuel O.
Endsley, L. E.
Erikson, E. S.
Evans, T. J.
Fuller, S. H.
Gulick, H. Jr.
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King, S. A. Jr.
Liebegott, G. H.
McCune, J. C.
McMahon, O. J.
Paar, O. H.
Parker, F. L.
Pickels, H. D.
Pollock, A. N.
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Roemer, Max
Roemer, Walter
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Tarr, Geo. B.
Thomas, T. H.
Turner, J. A.
Vowinkel, F. F.
Watt, J. R.
Wright, J. B.

PRESIDENT MITCHELL: The call of the roll will be dispensed with, the record of attendance being taken by the registration cards.

The reading of the minutes will be dispensed with, they having been already printed and distributed.

The following applications for membership were read by the Secretary:

Ball, Wendell P., Chainman, M. W. Department, B. & O. R. R., 4819 Monongahela Avenue, Pittsburgh, Pa. Recommended by J. A. Spielmann.

Burket, C. W., Motive Power Inspector, Penna. R. R., Verona, Pa. Recommended by G. C. Walther.

Cappeau, Wm., Draftsman, B. & O. R. R., 144 Hazelwood Avenue, Pittsburgh, Pa. Recommended by J. A. Spielmann.

Charles, John L., Statistical Clerk, Monon. Conn. R. R., 4820 Lytle Street, Hazelwood, Pittsburgh, Pa. Recommended by Wm. Penn.

Coe, C. W., Superintendent, W. & L. E. R. R., Brewster, Ohio. Recommended by C. O. Dambach.

Cook, C. C., Division Engineer, B. & O. R. R., 206 Suburban Avenue, Beechview, Pittsburgh, Pa. Recommended by J. A. Spielmann.

Curtis, C. A. Jr., Draftsman, Pressed Steel Car Co., 609 California Avenue, Avalon, Pa. Recommended by H. E. Krimmell.

Endsley, Louis E., Prof. Railway Mechanical Engineering, University of Pittsburgh, Grant Boulevard, Pittsburgh, Pa. Recomended by J. B. Anderson.

Erikson, Emar S., Assistant Chief Draftsman, Pressed Steel Car Co., McKees Rocks, Pa. Recommended by N. H. Wardale.

Fitzgerald, G. H., District Manager, The Bird-Archer Co., 1409 First National Bank Building, Pittsburgh, Pa. Recommended by F. H. Stark.

Gibson, Albert C., Chief Draftsman, Spang, Chalfant Co., 52

Dewey Street, Etna, Pa. Recommended by Wm. H. Ritts.

Hassler, J. H., Transitman, B. & O. R. R., 4819 Monongahela Street, Pittsburgh, Pa. Recommended by J. A. Spielmann.

Hindman, S. M., Railway Supplies, Oliver Building, Pittsburgh, Pa. Recommended by J. B. Anderson.

Johnston, P. H., President, Johnston-Davies Lumber Co., 1312 Union Bank Building, Pittsburgh, Pa. Recommended by Frank Ryman.

Katzen, Wm., Draftsman, Pressed Steel Car Co., McKees Rocks, Pa. Recommended by Harry Howe.

Linhart, Walter, Salesman, Reymer Bros., 2945 Espey Avenue, Dormont, Pa. Recommended by J. B. Anderson.

Marquis, W. H., Clerk, Pressed Steel Car Co., 507 Monroe Avenue, Bellevue, Pa. Recommended by Harry Howe.

McKnight, Wm., Clerk, Passenger Car Stores, Pressed Steel Car Co., McKees Rocks, Pa. Recommended by Harry Howe.

McMahon, O. J., Foreman Machine Shop, Pressed Steel Car Co., McKees Rocks, Pa. Recommended by Harry Howe.

Page, A. Jr., Estimator, Pressed Steel Car Co., 56 Kendall Avenue, Bellevue, Pa. Recommended by Harry Howe.

Rhodes, E. M., Assistant Engineer, B. & O. R. R., No. 20 B. & O. Station, Pittsburgh, Pa. Recommended by J. A. Spielmann.

Robbins, J. A., Chief Clerk to Agent, P. & L. E. R. R., 790 West Carson Street, Pittsburgh, Pa. Recommended by C. O. Dambach.

Roemer, Max, Inspector, Pressed Steel Car Co., 3330 Fleming Avenue, N. S., Pittsburgh, Pa. Recommended by Harry Howe.

Roemer, Walter, Foreman, Pressed Steel Car Co., 1115 Criss Street, Pittsburgh, Pa. Recommended by Harry Howe.

Rohbock, W. L., Chief Engineer, W. & L. E. R. R., Cleveland, Ohio. Recommended by C. O. Dambach.

Scott, Robert T., Manager, Independent Pneumatic Tool Co., 1208 Farmers Bank Building, Pittsburgh, Pa. Recommended by D. J. Redding.

Sloan, N. H., Clerk, Pressed Steel Car Co., 843 River Road, Avalon, Pa. Recommended by Harry Howe.

Slocomb, R. C., Transitman, B. & O. R. R., 136 Hazelwood Avenue, Pittsburgh, Pa. Recommended by J. A. Spielmann.

Snitzer, N. E., Bill Clerk, Penna. R. R., 2321 Sarah Street, S. S., Pittsburgh, Pa. Recommended by Wm. Penn.

Soffel, P. K., Real Estate and Claim Agent, W. P. Ter. Ry., Wabash Building, Pittsburgh, Pa. Recommended by C. O. Dambach.

Sturmer, George W., Special Representative to General Manager, B. & O. R. R., Baltimore, Md. Recommended by A. G. Mitchell.

Tate, James B., Clerk, Pressed Steel Car Co., 505 Forest Avenue, Bellevue, Pa. Recommended by Harry Howe.

Taylor, C. C., c-o Speck-Marshall Co., 314 Second Avenue, Pittsburgh, Pa. Recommended by W. A. Walter.

Vowinkel, F. F., Salesman, Dilworth, Porter Co. Ltd., Fourth and Burnham Street, Pittsburgh, Pa. Recommended by N. H. Wardale.

Wilson, L. H. Jr., Transitman, B. & O. R. R., No. 20 B. & O. Station, Pittsburgh, Pa. Recommended by J. A. Spielmann.

PRESIDENT: As soon as these names have been favorable passed upon by the Executive Committee the gentlemen will become members.

Mr. D. M. Howe, on behalf of the Committee on Nominations, which had been previously appointed by the Executive Committee, presented the report of that Committee as follows:
Mr. President and Members:

Your Nominating Committee appointed to nominate officers for the Club for the ensuing year beginning November 1st, 1914, beg leave to submit the following:

President—F. M. McNulty, Superintendent M. P. & R. S., Monongahela Connecting R. R.

First Vice-President—J. G. Code, General Manager, Wabash-Pittsburgh Ter. R. R.

Second Vice-President—H. H. Maxfield, Master Mechanic, Pennsylvania R. R.

Secretary—J. B. Anderson, Chief Clerk to Supt. Motive Power, Pennsylvania R. R.

Treasurer—F. H. Stark, General Superintendent, Montour R. R.

Executive Committee—L. H. Turner, Superintendent Motive Power, P. & L. E. R. R.; D. J. Redding, Assistant Superintendent Motive Power, P. & L. E. R. R.; F. R. McFeatters, Superintendent Union R. R.; A. G. Mitchell, Superintendent Monongahela Division, Pennsylvania R. R.

Finance Committee—D. C. Noble, President, Pittsburgh Spring & Steel Co.; E. K. Conneely, Purchasing Agent, P. & L. E. R. R.; C. E. Postlethwaite, Manager Sales, Pressed Steel Car Co.; A. L. Humphrey, Vice-President and General Manager, W. A. B. Co.; L. C. Bihler, Traffic Manager, Carnegie Steel Co.

Membership Committee—D. M. Howe, Manager, Jos. Dixon Crucible Co.; Chas. A. Lindstrom, Assistant to President, Pressed Steel Car Co.; A. Stucki, Engineer; C. O. Dambach, Superintendent Wabash-Pittsburgh Ter. R. R.; O. S. Pulliam, Secretary, Pittsburgh Steel Foundry Co.; Frank J. Lanahan, President, Fort Pitt Malleable Iron Co.; Harry Howe, Inspector of Castings, Pressed Steel Car Co.

Entertainment Committee—Stephen C. Mason, Secretary, The McConway & Torley Co.; R. H. Blackall, Railway Supplies; D. H. Amsbary, District Manager, Dearborn Chemical Co.

(Signed) D. M. Howe, Chairman.
Chas. A. Lindstrom,
Frank J. Lanahan.

PRESIDENT: Under the Constitution the voting for officers will be by letter ballot, and if the names suggested by

the Nominating Committee are in any respect not satisfactory, you are at perfect liberty to insert on the ballot any names you may desire.

SECRETARY: The following amendment to the Constitution has been proposed by the requisite number of members in writing:

"In keeping with the increase in membership of the Club it is thought desirable that the Executive Committee should consist of three or more members, instead of only three members, therefore we the undersigned members of the Club offer the following amendment to the Constitution:

Article IV, Officers, that the words "three elective Executive members" be changed to read "an elective Executive Committee of three or more members."

Article VI, Election of Officers, Sec. 2 and 3—Eliminate the word "three" so that the different sentences will read "by elective members of the Executive Committee instead of by the three elective members of the Executive Committee."

(Signed by ten members of the Club)

PRESIDENT: Under the Constitution this proposed amendment will lie over until the next meeting, at which time it will be voted on.

PRESIDENT: Gentlemen, we now come to the paper of the evening, which I am pleased to announce is by Mr. Samuel O. Dunn, Editor of the Railway Age Gazette, on the subject of "Government Regulation of Railway Operation," a subject which should be of great interest to all railroad men. It is my great pleasure to introduce to you Mr. Dunn.

MR. SAMUEL O. DUNN: Mr. President and Gentlemen:—The pleasure is all mine. It is a cause of great gratification to me and a great pleasure to have the invitation to address you, and to have had an opportunity to accept it. The Railway Club of Pittsburgh has a reputation which extends far beyond the limits of its membership. I think it is universally recognized as one of the best organizations of its kind in the country, and I feel very much honored to have an opportunity to come here.

GOVERNMENT REGULATION OF RAILWAY OPERATION.

By Samuel O. Dunn,

Editor of the Railway Age Gazette.

The subject of my paper, "Government Regulation of Railway Operation," was suggested by your President. I interpreted it to refer to regulation of what we ordinarily understand as operation, namely, the construction, equipping and maintaining of railways and the moving of their engines, cars and trains. It is, therefore, to regulation of operation in this sense that I shall confine myself.

There are some phases of this subject which it would be a waste of time to discuss. It would be a waste of time to discuss whether the government has power to regulate operation. It has been settled by the courts that both the states and the nation have that power. It would be a waste of time to discuss whether there should be some regulation of operation. There is already much of it, and everyone agrees that, so long as the railways are owned by private companies, there always will be and always ought to be a good deal of it. In fact, it is one of the advantages of private ownership that under it the government can regulate the management of railways, and one of the disadvantages of public ownership that under it the government cannot do so, simply because under public ownership the government is the manager. The large questions as respects regulation of operation which remain to be settled are, what its purposes should be, how comprehensive its scope should be, what form it should take, and by whom the regulating should be done.

A good many people have done little else for some years but evolve theoretically complete and perfect schemes for the regulation, not only of railway operation, but of all parts of the business of all kinds of public service corporations; and the less experience they have had in connection with the business of such concerns, the more assurance they have shown in setting forth how they should be regulated. We shall never get very

far by following such people. A satisfactory and helpful policy of regulation can be developed only by a painstaking study of the conditions to be dealt with by both railway officers and regulating authorities, and by co-operation between them in cautiously trying out regulatory measures until experience shall show what ought to be done and what ought not to be done, what can be done and what cannot be done. But frank discussion of the problem may, at least, tend to help bring about the needed study of the conditions and the needed co-operation between railway officers and the regulating authorities; and, therefore, frank discussion may do good, even though those participating in it may, as I do tonight, express their views with many inward questionings and with the reservation of the privilege of changing them if they are shown to be wrong.

Some Shortcomings of Railway Plants and Service.

The great requisites of good railway service are reliability, conveniency, comfort and safety. Our railway service has many shortcomings as respects all these matters. This is not saying that it is all bad; that it is worse than that of other railways; or that its shortcomings are due to any particular class or classes of persons. The service of some of our railways is better than that of others; in many respects our service is better than that of any other railways; and many of the shortcomings which it has are due to the special conditions under which it has been developed and is carried on. But after all, it must be conceded that we have much poor track, much defective equipment, many lines that are without block systems, many whose trackage, terminals and equipment are not adequate in normal times to the demands of their business, numerous unprotected grade crossings, many employes who have not been properly trained and disciplined or on whom training and discipline have been lost. In consequence, we have many trains that ride uncomfortably, many that are late, congestions and delays to traffic when business is good, and an accident record that is discreditable. This is but an incomplete enumeration of our railways' shortcomings of plant, personnel and service. It is desirable from the standpoint of all that these things shall be improved. If government regulation will help improve them, then government regulation is desirable. But if government regulation is to do

this it must courageously and effectively attack the primary causes of the unsatisfactory conditions. What, then, are some of these primary causes, and how may the government effectively attack them?

Causes of Unsatisfactory Railway Conditions.

The primary causes of the defects of plants and service are numerous and various. Among them is excessive competition. Many assume that competition always is wholesome, and regard it as the specific for all commercial and industrial ills. But, in the railway business at least, its effects are mixed, some being good and some bad. Competition between railways often tends to stimulate them to improve their track, equipment and train service. But when the competition in service becomes unequal because, for one reason or another, the financial resources of the competitors are unequal, it often does harm which largely offsets its good. The stronger lines are able to put and keep their track, structures and equipment in relatively good condition; to build second tracks where they are needed; to install block systems, and so on. The weak roads are not able to do all these things, and in the effort to get and hold business they are likely to do the things which attract the most favorable notice from the public and neglect those things failure to do which attracts the least unfavorable notice. The ordinary traveler judges railways chiefly by their passenger equipment and train schedules. Therefore, not a few railways are tempted in the competitive struggle to neglect their track, to refrain from installing block systems, and at the same time to buy and operate heavy modern passenger equipment and to publish as fast schedules for their trains between competitive points as are published by rival lines with better track and structures. Among the results are numerous late trains; running that is too fast for the track, with all its attendant discomforts and dangers, and contributions to the statistics of collisions and derailments published by the Interstate Commerce Commission, and especially to those regarding derailments, which within recent years have shown alarming increases.

Unrestricted competition in other lines of business may not so plainly have bad effects. In other businesses it results in the long run in the elimination of the weaker; and whether one

regards that as good or bad depends on his economic philosophy. But unrestricted competition between strong and weak railways always has some bad effects because in the railway business the weaker competitor never is and never can be entirely eliminated. The ultimate result of unrestricted competition is to reduce the weaker lines to a position where they will go on indefinitely rendering a service which is unprofitable to their owners and managers and unsatisfactory and unsafe to the public.

The most important reason for the shortcomings of the physical properties, and for many of the resulting defects of the service, of the railways of the United States is their relatively small earnings; and their relatively small earnings are due partly to their relatively light traffic, but more to their low rates. The railways of Germany earn over $22,000 gross per mile; those of Great Britain almost $27,000; those of Belgium over $22,500; those of Switzerland $15,000; those of France over $14,500; while the average for our roads has never been $13,000. Now, everything a railway buys must be paid for, directly or indirectly, from gross earnings. Furthermore, our railways have to pay wages twice as high as those of European railways. As the railway dollar of the United States will not go nearly as far as the railway dollar of Europe, and as the number of dollars earned per mile here is somewhat less than in France and Switzerland, only a little more than one-half as great as in Belgium and Germany, and less than half as great as in England, the opportunities our railways have had for putting their properties in good shape have been relatively much smaller than those of the other railways named. In their earlier history their earnings were small because most of them were built into undeveloped territory where the traffic was sparse, and as soon as a competing road was built they began destructive rate wars. Their earning capacity has continued to be too small because just when they very sensibly began to make traffic arrangements or community of interest arrangements to increase and maintain their rates and earnings government regulation stepped in and destroyed the arrangements or forbade the increases in rates.

Another important cause of the relative want of safety and other defects of our railway operation and service is the shortcomings of their personnel. We have been told by an authority whose views carry great weight with the public, viz., the Inter-

state Commerce Commission, that "The most disquieting and perplexing feature of the problem of accident prevention is the large proportion of train accidents caused by dereliction of duty by the employes involved." To the lamentable tendency of employes to disregard operating rules and take risks is also attributable a great majority of the casualties and fatalities—other than those to trespassers—which result from accidents other than train accidents. For example, while the application of automatic couplers to practically all engines and cars has largely reduced the accidents occurring in connection with coupling and uncoupling, there are still many of them; and their continuance is due mainly to the risks carelessly or recklessly taken by employes. The many accidents resulting from employes stepping in front of moving cars, engines and trains are due to the same causes. Probably the blame for such accidents should not be visited entirely on the employes. It is the duty of the managements to use all available disciplinary and educational means to instruct and train employes so that they will not be careless or reckless. But the employes individually, and their organizations also, owe a duty to themselves and others; and the state has its duty; and few who are familar with the conditions would say that the employes, their organizations and the various governments have done as much in proportion to reduce this fatal carelessness and recklessness as have the railway managements.

The same laxity which causes so many accidents is responsible for numerous other defects of service. While the frequent lateness of trains is often due to the policy of managements in publishing schedules which cannot be maintained, it is also often due to chronic delays at stations which can be stopped only by greater alertness and celerity on the part of station and train employes.

The statistics which constitute the worst feature of the accident reports of the Interstate Commerce Commission are those regarding fatalities to trespassers, which every year number more than one-half of all the fatalities reported. While the deaths of trespassers are charged up against the railways, as a matter of fact, the municipal and state governments, which do not make and enforce proper laws against trespassing, and not the managements of the roads, are responsible for them. They

are not really railway accidents at all; and, therefore, the statistics regarding them should not be included under that head.

What Has Government Regulation Already Done?

What has government regulation done about the various defects of the physical properties, of the operation and of the service of our railways? What can and should it do about them? And what form should the regulatory legislation be given, and to whom should its administration be entrusted?

There have been many laws passed by state legislatures and Congress, and many orders issued by state commissions and the Interstate Commerce Commission, for the regulation of operation. These relate to numerous and varied subjects, including safety appliances on locomotives and cars, drinking cups on trains, locomotive headlights, block systems, the drinking of intoxicating liquors on trains, the frequency with which employes must be paid their wages, the number of hours they may be kept on duty, the number of them that must be employed on trains, the elimination of grade crossings, the speed of live stock trains, the clearances between tracks and overhead and lateral structures, and so on *ad infinitum*. At almost every session of a state legislature some new kind of law, and at almost every session of some state commissions some new kind of order, for the regulation of operation is produced. It would be astonishing if all this mass of regulatory measures did not contain some that were good. But those which have been conceived in intelligence and public spirit and brought forth in justice are so few compared with the total that you will have great difficulty in finding them. Having found them, you are apt to think they are adventitious and not the result of deliberate thought and choice. Of all the subjects to which our law-making and law-administering bodies have applied themselves, to none have they devoted more stupidity, ignorance and unfairness than the regulation of railway operation. In most cases they have not tried to ascertain the conditions to be dealt with, the real evils to be remedied or the results their laws or orders probably would produce.

The character and the fruits of their labors have corresponded. If a bonfire were made of every state regulation in existence the operation of our railways would be made more

economical and their service better and safer; and there are some federal regulations which might well be added to the conflagration.

I have referred to excessive competition as one of the causes of the shortcomings of our railway service. Have the regulators perceived this and acted accordingly? On the contrary, the various anti-trust laws, and especially the federal anti-trust law, have been applied to railways in all their rigor. Every consolidation, agreement or arrangement designed to moderate the fury of competition has been treated as a crime. Some such arrangements, as, for example, that regarding differential passenger fares between Chicago and New York, under which the fares charged are adjusted to the service and schedules of the different roads and trains, have been tolerated. But the general tendency of regulation has been to encourage fierce competition, whereas the public welfare demands that such competition shall be discouraged. It would be to the interest of both the railways and the public for the roads to be permitted to make binding and enforceable agreements regarding both competitive rates and competitive service subject to the supervision of competent regulating bodies. The spirit of our laws is hostile to such action.

In some cases when railways with bad track have been running trains at unsafe speeds to meet the competition of roads having better track, state commissions have fixed maximum speeds to be observed until their tracks were improved. Such action is justifiable and desirable. But the need for it is created chiefly by excessive competition. Why continue to stimulate the cause while trying to nullify the effect?

Furthermore, such action by the commissions merely substitutes one kind of poor service for another, and does not go to the root of the evil. It is better that trains should be slow than that they should be unsafe, and our accident record would be better if some railways had fewer trains with schedules too fast for their track and facilities. But a reasonably fast service is desirable on all railways; and when the passenger trains of a railway cannot make good speeds safely the primary evil consists, not in their attempts to run their trains fast, but in the conditions of track, structures, equipment, signals and so on, which make it unsafe to do so. In that case the true function

of regulation is, not merely to fix some low maximum speed, but to ascertain the causes of the unsatisfactory physical conditions and stimulate and co-operate with the railway management in removing them. So as to all other deficiencies of roadway, equipment and service.

Now, while there has been much regulation purporting to be intended to cause physical improvements in railways, there has been very little which has been adapted to that end. Probably the best legislation for the regulation of railway operation ever passed was the safety appliance law enacted by Congress in 1893, together with the subsequent amendments to it. This law required the railways to equip their trains with power brakes, automatic couplers, secure grab irons and other safety appliances. But it did not require them to do anything which the investigations of their own officers had not shown was practical, or which the practice of many of the more progressive lines had not indicated was desirable; and it gave the Interstate Commerce Commission a broad discretion in administering the law, which made it possible for the railways and the Commission closely to co-operate. Such co-operation was secured, and the result has been a steady improvement of the safety appliances on equipment of all kinds from the passage of the law until the present time.

In this case it was right and desirable that the legislation passed should apply uniformly to all roads, because, as freight cars circulate freely throughout the country, it would be dangerous to have those of different roads equipped in different ways. But in many cases to apply the same provisions to large groups of roads or to all of them is unjust and injurious. The needs and deficiencies of different roads may be wholly different. One may have bad track and a good block system; another, bad track and good equipment; another, good track, but neither good equipment nor a good block system. Evidently if the same requirement, as for steel cars or block signals, is imposed on all, the results to the roads themselves and to the public will be widely different. If a road has bad track a law requiring it to install heavy steel equipment is almost certain to increase the number of accidents on it. Similarly, there is not the same need or justification for requiring the elimination of grade crossings on a road operating through a sparsely settled district as for requiring it on one operating through a densely populated territory.

In the preparation of most of the regulatory legislation such points have not been considered. The same requirements have been imposed on many, or even all, roads without reference to their differences in conditions. Railways have been required to use high power headlights regardless of whether they did not have greater need for block signals. They have been required to increase their clearances regardless of whether it would not have been more in the interest of safety for them to have spent the money on their tracks. They have been required to waste millions in employing useless men in train crews, when they needed the money to properly maintain their equipment. Even when improvements which were needed have been required the legislation regarding them often has been wholly unjust. In the city of Chicago the roads are being forced to bear the entire cost of elevating their tracks, which it is estimated will be $150,000,000, and this in spite of the fact that many more of their grade crossings have been created by streets being opened across their tracks than by their tracks being opened across streets.

Regulation of Operation Largely a Financial Question.

Finally, law-making bodies and commissions are disposed to require all kinds of expensive improvements, while persistently ignoring the fact that it will be impossible to put the railways of this country in satisfactory condition without increases in their rates and net earnings. When the roads ask for increases in rates an attempt always is made to show that they are earning enough on their *present* investment. The Interstate Commerce Commission in its decision in the Eastern rate advance case conceded that this was not true of the eastern railways. But even if it were true of all the railways, this would not show that there ought not to be general advances in rates. If the roads are now earning barely a reasonable return on their present investment, clearly they cannot, with present rates and earnings, raise the billions which must be invested if block systems are to be generally installed, grade crossings to be eliminated, tracks to be strengthened, better equipment to be provided and so on. Most of the investment for such purposes would add nothing to their earning capacity. But a return must be paid on the additional investment; the means of paying it cannot be obtained except by increasing earnings; and the necessary increase in earnings can be gained only by increases in rates.

The question of regulation of railway operation is chiefly a financial one. The railways would gladly make every kind of improvement which the public demands. But the various regulating bodies control what they may earn, and, therefore, what funds they can raise. Therefore, the financial problem of regulation of operation is squarely up to the regulating bodies. As long as the earning capacity of the railways is limited as it is now, to require many of them to make one improvement is in effect to forbid them to make others which may be more needed, simply because they have not enough money and cannot raise enough to make all the improvements that are needed.

Besides regulation to compel the railways to make improvements in their tracks, structures, and equipment, there has been a good deal affecting their relations with their employes. The federal government and many of the states have passed laws fixing the maximum hours that certain classes of employes may be kept on duty. Many of the states have passed laws requiring increases in the number of men employed in train crews. All of the legislation affecting the relations of railways and their employes has tended to increase expenses, and most of it has purported to be in the interest of safety. But a large majority of the so-called "safety" laws have been promoted by the brotherhoods of railway employes, and usually their real purposes have been to increase the number of men that must be employed by railways, and to promote the political interests of the lawmakers passing them. The enactment of the provision prohibiting employes from being kept on duty more than 16 hours was justifiable, although the number of accidents traceable to the overworking of employes always has been negligible. The provisions of the federal and the various state laws prohibiting telegraphers concerned with the operation of trains from being kept on duty more than from eight to nine hours, regardless of the extent to which they are concerned with train movement are, as safety measures, indefensible. The same thing is true of the train crew laws.

It is notable that while government regulation has meddled with matters of this sort it has been conspicuously careful to abstain from taking any steps to deal with those derelictions of their duty by railway employes to which the Interstate Commerce Commission attributes a large majority of train accidents.

When a railway employe in England or Germany is guilty of an infraction of duty which causes an accident he is pretty sure to be taken in hand by the government itself. Not so here. The noble and disinterested patriots who regulate railways and enforce laws in this country seldom forget for a moment the voting power of organized labor.

Why has past regulation of operation been what it has been? Too much of it has been inspired by prejudice and vindictiveness. Too much of it has been inspired by the representatives of labor brotherhoods seeking to promote the supposed interests of their members at the expense of the railways and the public, and adopted by lawmakers and commissioners who were thinking very little about the rights of the railways and the welfare of the public and very much about the votes they hoped to get by showing subservience to the labor brotherhoods. Too much of it has been inconsistent or conflicting because the several states and the nation have dealt with the same subjects in wholly different ways. Too much of it has been adopted in ignorance or disregard of whether the railways were able to bear the financial burdens imposed. Finally, most of the regulatory legislation has not been either drafted, adopted, or administered by persons possessing any expert knowledge of the matters with which they were dealing.

How Regulation Should Be Reformed.

Lawmaking bodies are more likely than commissions to be inspired by prejudice and political motives. They are less able than commissions to adapt their regulation to circumstances and conditions, for laws must be broad and sweeping in their terms. The commissions are more likely to act with knowledge, for their members have opportunity to study the conditions to be dealt with and to consider the probable effects of their measures, while lawmakers have not. Therefore, as far as is constitutional and practicable, the regulation of operation should be delegated to commissions. So long as the various states and the nation attempt to regulate operation independently, there will be inconsistencies and conflicts between the regulations adopted by the states, and between those adopted by the states and the nation. Therefore, either the states should be divested of their regulating authority or its exercise should be made subject to

the control of the central government. Most of our regulation of railway construction, maintenance or transportation causes an increase in railway expenses, and, therefore, such regulating should be either done or controlled by the body which chiefly controls railway earnings in order that a proper relationship between income and outgo may be maintained. For all these reasons, and for others that might be mentioned, the Interstate Commerce Commission should be given paromount authority to regulate, not only interstate operation, but all operation.

The Stevens bill, now pending in Congress, apparently would confer on the Commission the large discretionary authority over operation which it seems desirable it shall be given in order that the railways and the public may escape from still worse evils. It would, however, be folly to assume that the mere passage of this or some similar measure would solve the problem. The way laws are administered is as important as their provisions; and the character of their administration depends on the characters, attainments and abilities of those who administer them. Now, as to the personal character and ability of the present members of the Interstate Commerce Commission there is no question. But as to their fitness to administer a law giving them extensive authority to regulate railway construction, maintenance and operation there is serious question. The problems with which they would have to deal would be highly technical and extremely difficult. They are problems with which many men of great experience in railway affairs and of great ability have grappled for years with only partial success. They are problems of which no man can get even a fairly good working understanding without living in the closest touch with them for years. Now, the Commission contains only one man who has had experience in the operation of a railway, and he was not a railway officer. Two of its members were economists in our universities; and the other four were lawyers. Men with their training and experience can hardly know enough about railway mechanical, engineering, maintenance and transportation matters to regulate them intelligently; and it is hard to believe that anybody ever could learn enough about them to regulate them merely by serving on a commission.

The Commission's Organization for Regulation.

It would seem, therefore, that if the Commission is to be

given this extensive authority over operation a great effort should be made to secure the appointment to it of men with official experience in the operating departments of railways. As the Commission deals with a diversity of subjects doubtless it is not desirable that it should be composed entirely of such men, but certainly at least two of its members should be railway experts, one being, perhaps, a technical man of the calibre of chief engineer or superintendent of motive power, the other an operating man of the calibre of general superintendent or general manager. The British Railway and Canal Commission never has more than three members sitting at once, but the law requires at least one of these to be "of experience in railway business." The Railway and Canal Commission is merely a court which passes on rate cases. How much more important it is that a body such as the Interstate Commerce Commission should have members of railway experience!

Besides having members of railway experience, the Commission, if it is to regulate operation extensively, probably should have a subordinate body composed of experts in railway engineering, mechanical, maintenance and transportation matters to look after the details of this part of its work. It already has some subordinate bodies which devote themselves to such details. There is a chief locomotive boiler inspector with two assistants and district boiler inspectors throughout the country. There is a chief inspector of safety appliances with inspectors throughout the country. Unfortunately, almost all of these men have been selected because they were members of and were backed by railway labor brotherhoods. Very few of them have received a technical training, and almost none has risen in railway service above the rank of employes. This does not demonstrate that some of them are not men of ability and of special fitness for their duties. A large proportion of the operating and executive officers of our railways have risen from the ranks. A good many even of the technical experts of the railways, including chief engineers and superintendents of motive power, have done so. And there is no reason why men taken from the ranks by the Interstate Commerce Commission should not likewise demonstrate the possession of more than average ability and develop into experts. In fact, some of them have done so. But, plainly, if the Commission should organize a board to deal with the

problem of regulating construction, maintenance and operation, it would be preposterous for it to fill it with locomotive engineers, conductors and mechanics. Those appointed to such a board should have demonstrated their fitness beforehand; and men who had not risen in the railway service above the rank of employes would not have done this.

When the Commission was directed to undertake the stupendous task of making a valuation of all the railways it did not organize an engineering board composed of railway employes. It organized one composed of the president of the American Railway Engineering Association, of the chief engineer of one of the state commissions, of a man who was both a professor of civil engineering in one of the state universities and chief engineer of the railway commission of his state, and of two consulting engineers. In completing the engineering organization of its valuation department it has drawn men of recognized ability and expertness from the official ranks of railways all over the country. The example the Commission has set itself in organizing the engineering branch of its department of valuation should be followed if it should ever organize a board to have direct charge of its work of regulating operation. It should likewise be followed in selecting the men who doubtless would be employed in making inspections and investigations for it. Its inspectors and investigators should be chosen solely because of their special fitness to do their work fairly and intelligently, and not because they may happen to have the backing of some politician or labor organization.

The Various Steps in Regulation.

When the Commission shall have thus formed its organization, how should it proceed with its work of regulation? It would seem that it should lay the foundation for it by causing careful investigation to be made as to the conditions of railway plants or service which may be at fault and as to the causes of them. For example, if the statistics of the Commission continue to show an increase in the number of derailments it would obviously be the function and duty of the Commission to make or cause to be made an investigation to determine whether this was due to general or local causes and what remedy or remedies should be applied. If the Brotherhood of Railroad Trainmen

should petition the Commission for an order requiring increases in the number of brakemen employed on trains, or if the state legislatures should continue to pass so-called "full crew" laws, it would obviously become the duty of the Commission to make or cause to be made a careful and comprehensive investigation of the question whether a general increase, or local increases, or any increase at all, in the number of men employed on trains was required by the public welfare.

When the Commission believed that it had found bad conditions which demanded some action it would seem that its next step should be to arrange for conferences between its members or representatives and officers of the railways to ascertain whether the proper remedies could not be agreed upon and then applied by the managements of the railways themselves without the Commission issuing any formal order. The Commission in the past has had such conferences with representatives of the railways and of the railway labor brotherhoods regarding the administration of the safety appliance, hours of service and other laws. And in most cases they have led to agreements which were measurably satisfactory to the parties most directly concerned and have secured better results than would have been obtained by the issuance of arbitrary, formal orders which might have and very likely would have resulted in protracted litigation. It is probable that in a large proportion of all cases the railway managements and the Commission could agree as to what each of them ought to do, if they would confer more frequently, more frankly, more fairly and with a minimum of suspicion of each other's good faith. If after investigation and conference the Commission could not get any individual road or all roads to do what it thought should be done it would not follow that it must needs immediately issue some mandatory order. It would in a good many cases, if it exercised a salutary self-restraint, simply make public the facts, and then, for awhile at least, await developments. Publicity seems to many persons not to be a very sharp or heavy weapon, but, with all due respect to the Interstate Commerce Commission, the publicity which its hearings and reports have given to facts about the railway business which were previously unknown has, in my judgment, done a great deal more to raise the economic and moral standards of railway management in this country and to improve railway

service than the formal orders it has issued. The power of common sense exercised by making public facts and drawing suitable conclusions from them "does not," as A. T. Hadley has said in discussing the subject of railway regulation, "seem as strong as statutory power to prosecute people and put them in prison, but in the hands of a man who really possesses it is actually very much stronger." Only when other resources fail will a wise regulating body resort to the issuance of mandatory orders. And when it does so it will take the greatest pains to make them as little arbitrary as possible and as well adjusted to the special conditions of each case as possible.

When the Commission shall have completed its organization and set it to work it will be necessary, if its regulation of operation is to be fair and successful, for it to consider every time it issues an order whether the earnings of the lines affected are sufficient both to bear the additional expense its order will cause and to enable them to expend all the money in the maintenance and improvement of their properties which they would have needed to have spent if it had not issued the order. It will not be sufficient for the Commission merely to inspect, to find fault and to issue orders. The managers of most railways know the defects in their properties and service as well now as the Commission will ever know them. And most roads whose earnings are sufficient go ahead as fast as is practicable remedying these defects. Most railway managers are as anxious as the public or any railway commission to see their properties put and kept in the best conditions. Their great problem is to find the necessary money; and this is the greatest problem which the Commission will have to face and help the managements solve, when it undertakes the extensive regulation of operation; and if the Commission does not face that problem courageously and co-operate intelligently with the managements in solving it its regulation of operation will be a failure or worse.

Will Regulation Be Successful?

Suppose state regulation is entirely subordinated to federal regulation. Suppose federal regulation is placed entirely in the hands of the Commission. Suppose the Commission is given a large enough appropriation by Congress properly to perform its functions. Will regulation of operation then be made fair, con-

structive and beneficent? Will the politicians let the Commission alone so that it can do its work right, and will the Commission prove big enough for the job? These are questions no one can answer. The only way to find out will be to try the experiment, as we are now trying that of making a valuation as a basis for the regulation of rates. If it is tried, like the experiment of valuation it will cost the public and the railways large sums; and the new burdens of the Commission, together with its present burdens, will give it the heaviest duties and responsibilities ever imposed on any body of men in this country. If the Commission tries merely to regulate the railways and not to manage them the experiment may succeed. If it tries to manage them, as it now seems to be trying to manage them under the guise of regulating rates, the results of the experiment will be widely different. In its regulation of rates the Commission, instead of confining itself to the duty imposed on it by law, that of determing the reasonableness of rates in view of the actual situation of the railways, is trying to tell their managers all about how they can do their work better, so as to change the situation and thereby effect savings that will make unnecessary advances in rates, which, under present conditions, are conceded to be needed. Now, while the Commission may be able by purely corrective measures to protect the public from abuses which arise in connection with the financing of railways, the making of their rates and the rendering of their service, it never will be practicable for any single body of men, however able they may be and however much expert knowledge they may have, successfully to control the policies and direct the management of all the 250,000 miles of railways in this country.

Let us, therefore, hope that the more authority the Commission is given the more self-restraint and the more disposition to confine itself to its proper functions it will show. Let us hope that it will avoid letting its judgment be warped by the egotistical assumption that because it possesses superior power it must also possess superior wisdom—an assumption which seems rapidly to destroy the sense of proportion of every bureaucracy and which in the long run always has made every form of paternalistic government a failure and a curse to mankind. The Commission might do a great deal more good with its present powers if it would exercise them with a somewhat

franker recognition of its own limitations and in a broader spirit of co-operation with the railway managements. And it may do very little good and much harm with much larger powers unless it shows the greatest patience, forbearance, expertness and courage in exercising them. Wisdom is demonstrated, not by the possession, but by the manner of the use of power; and the success of government regulation of railway operation will not be determined by the amount of power conferred on the Commission, but by the way in which the power that is conferred is exercised.

PRESIDENT: The question is now open for discussion. I notice that we have with us Mr. Sturmer, Special representative of the General Manager, Baltimore and Ohio Railroad. We would be pleased to hear from him.

MR. GEORGE W. STURMER: Mr. President and Gentlemen of The Railway Club of Pittsburgh:—It affords me great pleasure to be with you this evening as a vistor. In my line of work I naturally come across many incidents that give me food for thought in railway circles. I have been in the railroad business for 37 years. I have done all kinds of work that calls for railroad building from top to bottom. And in my present position I have a system to travel, looking into all kinds of work pertaining to railroad matters, also taking care of employees, seeing that they are well taken care of, seeing that they do not transgress the laws and regulations laid down by the Interstate Commerce Commission, that they do not work over sixteen hours, and all the activities that pertain to their work.

As I heard our friend, the author of the paper, read this little book I realized that it is a book full of food for thought for every man connected with the railways. While of course he touches on the various regulations of railroad matters to such an extent that some of his hearers may not quite understand the conditions under which they were brought about and while I am not prepared tonight to discuss this paper as I would like to, there are some things connected with it that have drawn my attention and which, no doubt, will be food for thought for you gentlemen when you retire home tonight to think over this matter.

Railroads must be handled by practical men to bring results.

There is no railroad that can go out into the country and pick up a country boy and bring him into the city and put him on a railroad train, that can expect results from him in one or two years. The railroads all spend thousands and thousands of dollars to educate their young men, and the knowledge we have attained in the last thirty years in the railroad line has come from men that started at the foot of the ladder and climbed to the top. Every man in railroad life has a duty to perform. Educated on that duty, he naturally will follow that vocation just as long as he can possibly stand up to it. That is, the vocation of a railroad man is and has been his following for a lifetime. It seems as though oftentimes when an accident occurs most generally the question arises at once what is the cause of it. Well investigations sometimes prove that the man has been negligent in carrying out the rules and regulations laid down by the management for him to work to. Again there are some unfortunate things. Accidents will occur as long as there is a railroad. And while those things are going on the question arises, how can they be improved.

For myself, I always did believe and I will frankly say that the decisions rendered of late and the laws that have been inaugurated have not been in the past what they should be simply because of misunderstanding of railroad conditions.

I feel satisfied in my own mind that I have come to a place where I can gain some knowledge. I am a great listener and a poor talker. And I hope that on my next visit to Pittsburgh I may be permitted to put my application for membership into this organization and become one of your worthy number.

PRESIDENT: I notice that Professor Endsley, of the University of Pittsburgh, is with us and we would be glad to hear from him.

MR. L. E. ENDSLEY: Mr. President and members of The Railway Club of Pittsburgh, it gives me great pleasure to be here tonight attending my first meeting of this Club. As some of you know, I have been located out at Purdue University, at Lafayette, Indiana and my railway club was the Western Railway Club. We are very proud of that Club there, but when I came here I decided to become one of your members, if you would permit it. And I have met a great many friends here whom I have known in the railway world. I have devoted

most of my time in the railroad game from the university end of it, and I shall continue to do so in your midst in Pittsburgh. I want to become very well acquainted with the railroad men here.

We have very little knowledge except by practice in the railroad world. We try things, and if they work we succeed, and if they do not we try something else. I am glad to be here to listen to this paper. It is a very good paper. I read it over carefully. And I wonder how many men had thought of all the things in it. Very few of us. Our politicians have been running things, and it reminds me of a story I heard today. A man was standing in front of his home a few days before election and Politician No. 1 came along and gave him $1.00 to vote for him. He said "all right." He stood a little while and Politician No. 2 came along and said "I want you to vote for me." He said "all right, I will" and he gave him $2.00. A little bit later the third politician came along and gave him $3.00 to vote for him. He went into the house and told his wife how easily he had made $6.00. Well she said "Which one are you going to vote for?" He said "I have thought it over pretty carefully and I will vote for the one that gave me $1.00." She said "Why?" He said "He was the least corrupt."

Gentlemen as I have read the laws passed in the different legislatures of this country it has amused me very much to see the absurd things that are encountered. It does amuse a man who is familiar with things to read the laws that are proposed and some of them passed. I was very much amused last year to hear in the Railway Club of Chicago a little story which will apply here possibly. It was in the state of Wisconsin. The legislature there has done some good things. But a farmer who had been elected to the legislature was passing from his home town through a junction point and had to get his lunch at the lunch counter. They charged him 10 cents for coffee and 10 cents for a sandwich. A railroad man sat next him and he got his for 5 cents each. This farmer went right to the legislature and proposed a bill that all railroads must post in their lunch halls a list of the prices of everything and they must sell it to everybody at the same price. It shows the littleness and the narrowness of some legislators, the personal equation that enters into it.

I think the statement made by the speaker tonight when he said that the question of regulation is a question of finances, is the biggest question which he raised in his paper. We can not expect to regulate the roads unless we give them financial means to do it. The block system increases the freight tonnage but very little. Other things which are required do not do that. When we say that the Commissions must impose these things, all of them or most of them good, can we expect them to do it on the earnings they have been making when they have not been able to do it themselves? Most men in the railroad game today are as honest and as good as in other lines of work, and I believe a great deal better. There are some politicians in the railroad game, very few. And there are some lawyers on the Commission, but I did not know there were five. That is a good many.

That reminds me of a little story I heard today about a lawyer. He was cross examining an old lady who had married a burglar. He said to her. "Did you know this man was a burglar when you married him?" She said "Yes." "Well why in the world did you marry him?" "Well" she said "There were two men trying to get me and I had a hard time to decide between them. There was this man and a lawyer and I took this man."

PRESIDENT: Our Second Vice-President is General Manager of the Wabash-Pittsburgh Terminal Railroad and I know you will all be glad to hear from him, Mr. J. G. Code.

MR. J. G. CODE: Mr. President and Gentlemen:—No one could be better fitted to present the facts of the present situation than the speaker of the evening, and none could have presented them in more concise or direct form. The paper gives me subject for much thought, and I would say that unlike the previous speaker many of these regulations of operation which are to him amusing are far from being amusing to the man that has to go up against them.

The principal thought which this paper brings to my mind is "What are we going to do about it?" What can we do as railroad men to bring about the co-operation which is necessary between all railroads and all railroad men and between them and the various Commissions, to get the best results out of proposed regulation and the regulation for which provision

exists? I am not prepared to answer the question myself, but it is one of which we have all to think. How are we to get representation on those various Commissions of men who are qualified by practical experience to pass upon the questions that come before them. We need this co-operation that has been suggested without a doubt, and we need perhaps in all our operations a more general exhibition of common honesty in our dealings with each other, with our employees and with the Commissions. One difficulty in our dealing with our Commissions has been the fact that conclusions are frequently reached by them upon ex parte testimony, on testimony from investigations made by their representative without an opportunity for the railroads to be heard. And the conclusions once reached are difficult to overthrow. We have much to think about in this connection. What are we going to do about it?

PRESIDENT: We would like to hear from our Treasurer, Mr. F. H. Stark who is General Superintendent of the Montour Railroad.

MR. F. H. STARK: Mr. President and Gentlemen:—It would be folly to for me to undertake to elaborate on this subject for I will frankly confess that the author has covered more points than any of us ever dreamed of and so intelligently that it would be inappropriate for me even to comment on them. I heartily agree with almost all that he has said and my estimate of his conclusions is enhanced by the fact that he has the boldness to criticise the Interstate Commerce Commission personnel because too many of them are lawyers, while he himself was admitted to the bar.

I know from experience that the orders of the Federal and State Commissions are in some respects somewhat of a hardship, and yet at the same time, there are many of the requirements that are working out for the good of the railroad and the safety of the public. They may be in some cases a little bit too exacting, but it is so with all regulations—the standard is placed high in order to accomplish a safe average. There is a growing sentiment to regulate not only railroads but also the government of municipalities and I believe there is a trend in that direction that will bring about in the end better government by more consistent administration under conservative interference on the part of the people or in other words, reasonable regulation. There is

no question that the railroads will feel this burden of expense, especially at this time but the Interstate Commerce Commission and the railroads will understand each other better and all work in harmony to one end, good service and fair compensation.

PRESIDENT: Our past president, now a member of the Executive Committee, is Superintendent of the Union Railroad. We would like to hear from him. Mr. McFeatters.

MR. F. R. McFEATTERS: Mr. President and Gentlemen:—I do not feel that I can add anything to what has been said tonight. The paper has certainly brought out more than we had expected. I do not think it is up to the railroad men of this district to criticise the Interstate Commerce Commission at this time.

PRESIDENT: We have also a past president who is connected with the P. & L. E. R. R. in the position of Assistant Superintendent of Motive Power, Mr. Redding.

MR. D. J. REDDING: Mr. President, I am in the same fix as Mr. McFeatters. I might ask a question, though, of Professor Endsley. My friends next to me asked what ward that fellow lived in that got the $6.00. I would also like to answer the question as to what we are going to do about it. I had occasion to inquire some time ago as to what the political organization was down at Coraopolis, and the reply was "You ought to know. Stark is the big man in politics down there. He has control of the Council and his right hand man down there, Mr. Haynes, is on the school board and they have got all the votes corralled." I think we have got to follow their example and get into politics ourselves. Outside of that I do not know that I can offer anything except to endorse the sentiments of the gentleman who read the paper.

PRESIDENT: We have a gentleman with us who never fails to entertain the Club when he speaks, Mr. Blackall.

MR. R. H. BLACKALL: Am I correct in understanding that you take my remarks as a joke? I think that this subject is one that should be discussed principally by railroad men as they are more conversant with the many ways in which the laws compel them to spend money, but they seem to be a little backward in stating their ideas; possibly because they know the proceedings are to be published. The conditions which exist

are the result of various things, but many of the railroads are in trouble due to increased expense of operation and, in some cases, to mismanagement. The railroads are the backbone of the life of our country and, regardless of how they got there, they are in trouble, and getting them out of it is a case of MUST. What they need is money, and great trouble is being experienced by them in obtaining it as the bankers are not inclined to make loans where the earning capacity is inadequate. Everyone recognizes the necessity for supervision of railroads in order, among other things, to reduce financial mismanagement to a minimum, that the greatest good may come to both the roads and the public. As far as I am concerned, and I think the feeling is quite unanimous among the manufacturers of railroad supplies, I would be very glad to stand my quota of the greater expense incurred as a result of increased freight rates. What we want is increased freight rates and hand in hand with it must come supervision, but it should be supervision less politics.

PRESIDENT: The same remarks applied to the previous speaker would apply to Mr. Stucki an Engineer who is one of our Officers.

MR. A. STUCKI: I agree with the former speakers that this paper deals with a most important subject in a most thorough way. I read every word of it before I came here and I was astonished at the plain and convincing conclusions from one end to the other.

For illustration, government supervision and regulation is now considered as the means of stimulating fair and just competition between the various roads. The more regulation we get, the more wholesome competition is said to follow. Now the ideal form of regulation would center in government ownership and then we would have a right to expect a maximum amount of competition. This, strange to say, is not the case. On the contrary, the competition at once disappears and the passenger or the shipper has no redress whatsoever. In other words, you would then have to face a real monopoly, as some of our European friends choose to call it.

I often wondered how this comes about and now I find the explanation on page one, where the author says:—"In fact it is one of the advantages of private ownership that under it the

government can regulate the management of railways and one of the disadvantages of public ownership is that under it the government cannot do so, simply because under public ownership the government is the manager." I could mention many similar occasions, proving that Mr. Dunn was very thorough in presenting the subject.

MR. F. H. STARK: Mr. President, Mr. Code raised the question as to what we are going to do about it. We have a man who has retired from industrial life, who told the railroads at one time how they should do things when the railroads complained about the manner in which he prepared his loading of cars. I would suggest that Mr. Kirk tell us what to do about it.

Mr. T. S. KIRK: Mr. President and Gentlemen:—I shall take exception to Mr. Dunn's paper in its bearing on Government Control, through the instrumentally of the Interstate Commerce Commission. I cannot believe this Commission was invoked, except by assuming that there was imperative necessity for some regulation to safeguard the public against abuse by the corporate interests. It was not called into being impulsively, but after deliberate consideration it was considered as a necessary step to safeguard the lives of the employee, and at the same time to secure the public against unjust discrimination in freight rates. Is the present effort on the part of the railroad interests to increase their carrying rate justifiable on any ground except as an effort to gain through extortion? In my experience as a forwarding agent extending through many years, I am convinced that if the railroads would by introducing a system of higher efficiency in their management, they would need no nursing bottle to nourish them. The average time of delivery between here and Chicago is from twelve to fifteen days per car. The necessary time should not exceed forty-eight hours. This at the lowest minimum of movement today shows an actual loss of 240 hours or a service loss per car of something like 600 per cent. I fail to see why, with this wilful and proflegate waste of opportunity, the railroad should have the audacity to ask their patrons to pay a higher rate to make up a deficiency, wholly within their power to supply by the exercise of even moderate business management. Mr. Dunn places stress on the evils of competition; by his contention, the railroad that equips its line with all the modern facilities must

not use these improvements, if by so doing it may benefit its patrons at the injury of some poorly equipped line who would wish to compete, but cannot except by exacting exhorbitant rates. It is my contention that competition is still the spur that makes the progressive man of business, and that it is still the man who attends strictly to his business that succeeds. The railroad that is best prepared should do the business.

It is a great pity the Interstate Commerce Commission had not been empowered with greater limitation, and exercised its functions to restrain the rasculity that wrecked the New York New Haven and Hartford Railroad in this instance and that of the C. H. & D. Railroad the Government Control fell far short of what we laymen think it should do to protect the innocent against the vandals of high finance that virtually controlls all railroads.

These remarks may grate harshly on the ears of some of the railroaders present, but not being interested in railroads, I am totally indifferent as to what they may say or think. I believe that laws are generally enacted to restrain the lawless and that the innocent law abiding individual is seldom or never inconvenienced by them. Thanking you for your attention, I shall retire to that seclusion from whence I should not have been drawn.

PRESIDENT: If there is no one else who wishes to discuss the paper I will ask Mr. Dunn to close the discussion.

MR. SAMUEL O. DUNN: Mr. President, I have been very much interested in what Mr. Kirk, especially, has said. I do not think he entirely caught the drift of my remarks. In the first place I certainly did not mean to imply that perfection had been the rule in railway management in this country. If it has been, there have been some notable exceptions to it. and he can not say anything more severe about the New Haven scandal than has been said in the editorial columns of the Railway Age Gazette, and he can not say anything more severe about Mr. Mellen's management than was said about it in the Railway Age Gazette while Mr. Mellen was still President of the New Haven.

Respecting the matter of regulation, I was not opposing any regulation of railroads, I was advocating the regulation of railroads. The paper clearly indicates that its writer is in favor

of the passage of the Stevens Bill which would give the Interstate Commerce Commission very broad powers to regulate railroad operation. What I attempted to do was not to oppose any regulation of railroads, but to oppose the kind of regulation of railroad operation which has usually prevailed and to advocate a better kind of regulation, and that in my opinion is the attitude of practically all of the railroad officers of this country whose opinions carry any weight now.

A man may very consistently advocate reasonable, intelligent, expert regulation and at the same time oppose for example, the so-called full crew regulation which we have had, in several states. There have been any number of state legislative acts which a man who favors reasonable regulation may nevertheless condemn unstintedly. I have always been an advocate of government regulation.

With reference to the railway financing to which Mr. Kirk refers, the railroads of this country never lifted a finger to prevent the enactment of legislation for the regulation of railroad securities issues such as was advocated by the Hadley Railroad Securities Commission which was created by Congress and appointed by President Taft. The railroads have opposed the sort of regulation of the issuance of securities which has been proposed at the present session of Congress, but I have no doubt that if the bill which was recommended by the Hadley Commission had been introduced the railroads would not have opposed it.

The question of railway mail pay, affords a good illustration of the attitude of the government toward the railways and of the roads toward the government. The railways have been charging for years that they have not been sufficiently paid. The post office department, on the other hand, was constantly cutting down their pay and trying to make further cuts. Finally Congress appointed a joint committee on railroad mail pay, which at the time it was appointed consisted entirely of members of Congress and which contained only two men who were not members of Congress at the time its report was made. That Committee, which recently made its report, upheld practically every contention which the railroads had made in respect to the compensation which they were receiving, and after the report was made the committee of the railroads on mail pay issued a

statement saying they were willing to accept the report of the Congressional Committee.

I think those two instances are enough to illustrate the fact that most of the railroad managers of this country are not opposing reasonable regulation; but that what they are opposing, and what they have a right to oppose, and what everybody ought to oppose, is the sort of unfair regulation to which they have been subjected.

PRESIDENT MITCHELL: The speaker has in his paper expressed my views much better than I possibly can and I therefore endorse what he has so ably said. The Railroads, so far as I know do not object to regulation if intelligently and wise administered. What they object to is unfair and foolish regulation. Take for instance a bill proposed in Congress concerning the substitution of steel for wood in passenger equipment, requiring same to be accomplished by a certain time, and had the cost estimated at over six hundred million dollars not been prohibitive, all of the car shops in the country working full time could not have done the work required. Equally as foolish legislation is attempted in the legislatures of the several states. In my judgment the proper way to accomplish the ideal condition would be the concentration of authority over the railroads in the hands of the Interstate Commerce Commission with the State Commissions abolished, or made subordinate to the National Commission in all matters affecting Railroads, having that body divorced entirely from politics or political influence, composed of one recognized railroad expert from each State, paid a salary sufficient to command his full time, and for an unlimited term of service. Such a position in fact as would be attractive to an Executive Officer of our largest Railroads and where ability acquired by many years of training could be exercised.

I do not know whether such a scheme would be practical or not but it would have at least the merit of regulation by past masters of the science of railroading instead of regulation by students and would, if it could be accomplished, bring increased efficiency and better satisfy the public.

MR. D. M. HOWE: Mr. President, Mr. Dunn has given us one of the most intelligent and broad-minded papers that has

ever been read before this Club, therefore, I move we extend to him a rising vote of thanks.

The motion was carried by unanimous rising vote.

MR. HOWE: While I am on my feet I want to make another motion. We have had quite recently some very honorable and capable men added to our list of honorary members. I move that the name of Mr. Samuel O. Dunn, Editor of the Railway Age Gazette, be added to our list of honorary members.

The motion was carried unanimously.

There being no further business,

ON MOTION, Adjourned.

J. B. Anderson

Secretary.

The Society of Railway Club Secretaries held its Eighth Annual Meeting, June 14th, 1914, at the Marlborough-Blenheim Hotel, Atlantic City, N. J., Mr. J. B. Anderson, of Pittsburgh, Chairman presiding.

Other members present were:

Mr. Daniel M. Brady, President, Brady Brass Company, New York City.

Mr. Harry D. Vought, New York City. New York Railroad Club.

Mr. Harry D. Vought, New York City. Central Railway Club.

Mr. A. J. Merrill, Atlanta, Ga. Southern and Southwestern Club.

Mr. James Powell, St. Lambert, Canada. Canadian Railway Club.

Mr. W. S. Rosevear of the Western Railway Club of Canada was also present as a visitor, and gave the pleasing notice that his organization desired to be enrolled as a member.

The Minutes of the Seventh Annual Meeting having been previously distributed, and there being no omissions or corrections, were ordered approved.

Mr. Vought reported that in accordance with action taken a year ago, a full statement had been made for the information of the Cincinnati Club, of the objects and aims of the Society and the work it had done. The Minutes of the Seventh Annual Meeting had been forwarded to its Secretary, Mr. H. Boutet, who was the guest of the Society in 1913, but nothing further had been heard from that organization on the subject of membership.

It was agreed that the Chairman should pursue the subject further during the year.

It was further reported by Mr. Vought that the work of organizing the Society of National Technical Associations' Secretaries had made progress to the point where everything was in readiness for the first general meeting to complete the same and which would be held some time in October.

Attention was directed to invitations for an informal dinner to be held on the evening of the 13th for the consideration of questions relating to efficiency in advertising, issued by Mr. L. F. Hamilton, Advertising Manager of The National Tube Company of Pittsburgh, Pa.

After same discussion it was agreed that as no opportunity for conferring with their respective Executive Committees had been afforded members of the Society, it would not be advisable to participate in the dinner and that proper explanation of this would be made to Mr. Hamilton by the Chairman of the Society.

The Secretary recommended that the Northern Railway Club be dropped from membership, in view of statements as to its status made by its Secretary, and it was so ordered.

The further report was made by the Secretary that official badge ordered by the Society for the Secretary of the New England Railroad Club had been delivered and the acknowledgment of the recipient received.

The Secretary reported that the total number of copies of the Index of Subjects published by the Society and distributed to members of railroad clubs for 1913, was 7,308, which did not include requests received for copies from other sources from time to time, and it seemed to indicate the usefulness of the publication and appreciation of its purpose.

Reference was made as follows of prospective memberships:

Mr. Powell, Canadian Northern of Toronto.

Mr. Anderson and Mr. Merrill, Cincinnati.

Mr. Merrill, Chattanooga.

It was agreed that members would in future bring to annual meetings, the list of subjects and authors of papers before their Club during the preceeding season.

Approval was given to a statement of receipts and disbursements by the Secretary-Treasurer showing that the Society still has a fair surplus for contingencies, and an appropriation of $25.00 was ordered for expenses incurred by him in carrying on the work of the Society during the past year.

An invitation from Mr. Brady for the members to be his guests at luncheon after adjournment was accepted, with thanks to the host for his courtesy.

Officers for the ensuing year were elected as follows:

J. B. Anderson, Chairman; Pittsburgh.

A. J. Merrill, Vice-Chairman; Atlanta, Ga.

Harry D. Vought, Secretary-Treasurer; New York City.

After an informal discussion of matters connected with the duties of the members of the Society in their respective Clubs and the methods employed in handling work incident thereto, the Society adjourned.

Respectfully submitted,

HARRY D. VOUGHT,

Secretary-Treasurer.

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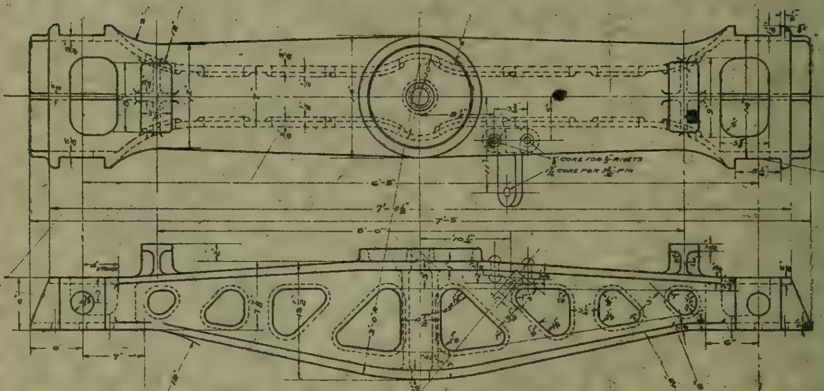

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RAILWAY CLUB OF PITTSBURGH
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Annual Meeting, Election of Officers, Smoker, Vaudeville, Names of Members.

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, OCTOBER 23, 1914.

The Annual Meeting of The Railway Club of Pittsburgh was called to order at the auditorium of the German Club, Pittsburgh, Pa., at 8 o'clock P. M., by President A. G. Mitchell.

The following gentlemen registered:

MEMBERS.

Adams, Lewis
Albree, C. B.
Amsbary, D. H.
Andresen, A. M.
Anderson, D. W.
Anderson, J. B.
Anderson, J. P.
Antes, E. L.
Austin, F. S.
Babcock, F. H.
Bailey, R. E. L.
Baker, J. H.
Barth, J. W.
Barker, A. E.
Batchelar, E. C.
Battinhouse, J.
Bealor, B. G.
Berg, K.
Bernard, R. Y.
Bihler, L. C.
Blackall, R. H.
Backoski, J. G.
Bond, W. W.
Bowden, T. C.
Boyer, Chas. E.
Brand, Thos. Sr.
Brashear, John A.
Brown, A. D.
Brown, J. T. Jr.
Brunner, F. J.
Burke, Wm.
Burket, C. W.
Burry, V. J.
Butler, W. J.
Byron, A. W.
Cato, J. R.
Caton, S. W.
Cassiday, C. R.
Chamberlain, W. A.
Chapman, B. D.
Chittenden, A. D.
Clark, C. C.
Cline, W. A.
Code, J. G.
Conner, W. P.
Cooner, L. D.
Cooper, J. H.
Cooper, W. M.
Copeland, F. T.
Cotton, A. C.
Courtney, D. C.
Crenner, J. A.
Crouch, A. W.
Curtis, W. R.
DeArment, J. H.
Deane, Robert
Detwiler, U. G.
Drake, W. C.
Dunlap, A. N.
Dunlevy, J. H.
Edwards, G. H.
Elkin, W. C.
Elverson, H. W.
Emery, C. W.
Emery, E.
Endsley, L. E.
Englert, A. F.
Falkenstein, W. H.
Ferguson, R. B.
Flaherty, P. J.
Fluent, B. F.
Fogle, E. F.
Forcier, C. W.
Frasher, J. D.
Frazier, E. L. Jr.
Francis, W. S.

Freshwater, F. H.
Fulton, A. M.
Gale, C. H.
George, M. E.
Gies, Geo. E.
Gillespie, W. J.
Greiff, J. C.
Grewe, H. F.
Gross, C. H.
Guay, J. W.
Hackenburg, J. H.
Hair, H. J.
Hall, C. W.
Hardman, H. J.
Harner, A. J.
Harriman, H. A.
Hastings, C. L.
Haynes, J. E.
Heird, Geo. W.
Helm, E. E.
Henry, J. M.
Hepburn, M. J.
Herman, W. J.
Herrold, A. E.
Hilty, H. A.
Hindman, S. M.
Hink, G. L.
Hoffman, C. T.
Holt, Jas.
Howe, D. M.
Howe, Harry
Howe, M. E.
Howe, W. C.
Huchel, H. G.
Hudson, W. L.
Huff, Geo. F. Jr.
Hunter, J. A.
James, J. H.
James, R. E.
Johnson, W. A.
Johnston, P. H.
Jones, A. W.
Jones, M.
Jordon, J. E.
Kelly, H. B.
Kensinger, E. A.
Kinter, D. H.
Kirk, T. S.
Knickerbocker, A. C.
Knight, E. A.
Koch, Felix
Koll, J. F.
Krimmel, H. E.
Krahmer, E. F.
Lamb, E. H.
Lanahan, Frank J.
Lanahan, J. S.
Lang, W. C.
Lansbery, W. B.
Laughner, C. L.
Lindner, W. C.
Lindstrom, F. J.
Linhart, W.
Livingston, B. F.
Lobez, P. L.
Lockwood, B. D.
Long, R. M.
Loughner, M. F.
Lyle, D. O.
Lyons, R. S.
Mackert, A. A.
Macfarlane, W. E.
MacQuown, H. C.
Manns, F. F.
Martin, F. J.
Maxfield, H. H.
Mellon, W. B.
Mensch, E. M.
Miller, F. L.
Millar, R. J.
Mitchell, A. G.
Mitchell, J.
Mott, S. L.
Murphy, W. J.
McAbee, W. S.
McCann, J. P.
McCollum, G. C.
McFarland, H. L.
McGrory, P.
McKeen, J. W.
McKinstry, C. H.
McNaight, A. H.
McNulty, F. M.
Neff, J. P.
Neel, T. M.
Orbin, G. N.
Orchard, Chas.
O'Brien, W. P.

Page, A. Jr.
Parke, F. H.
Pearson, A.
Pechstein, A. J. G.
Penn, Wm.
Pie, J. J.
Porter, Chas.
Porter, H. V.
Porter, W. E.
Pratt, I. D.
Proven, John
Rabold, W. E.
Radcliffe, G. H.
Raser, Geo. B.
Redding, D. J.
Reymer, C. H.
Reed, W. S.
Richardson, L.
Richardson, W. P.
Richers, G. J.
Riley, J. W.
Robbins, F. S.
Roemer, Max
Roemer, W.
Rohn, W. B.
Rowand, T. A.
Runser, K. W.
Ryman, F.
Sanderson, W. W.
Schiller, John
Schauer, A. J.
Scheck, H. G.
Schultz, G. H.
Scott, R. T.
Sewell, H. B.
Shallenberger, C. M.
Sheets, H. E.
Shipe, W. E.
Shook, S. D.
Shourek, T. L.
Shuck, Wm. C.
Shults, I. J.
Sigafoos, Gus
Sleeman, W. C.
Smead, D. N.
Smith, E. M.
Smith, J. B.
Smith, J. H.
Smoot, W. D.
Snyder, F. I.
Snyder, J. W.
Stark, F. H.
Stucki, A.
Suckfield, G. A.
Swayne, H. B.
Swope, B. M.
Tate, J. B.
Thompson, C. H.
Thurlby, A. R.
Toomey, J. J.
Towson, T. W.
Trappe, W. C.
Tucker, J. L.
Turner, L. H.
Turner, W. V.
Voight, A. J.
Vowinkel, F. F.
Walter, W. A.
Wardale, N. H.
Warfel, J. A.
Watkins, G. H.
White, F. L.
Williams, W. W.
Williamson, J. A.
Wilson, T. A.
Woernley, H. F.
Wyke, J. W.
Yon, H. C.
Zinsmaster, F.

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Africa, J. H.
Andresen, A. C.
Anderson, G. C.
Anderson, G. N.
Barr, J. D.
Beals, J. T.
Beirwell, L. T.
Bell, Jas. E.
Bennett, Dr. O. J.
Bohannen, G. L.
Booker, G.
Boone, Wm. M.

Bonheyo, J. A.
Callahan, J.
Campbell, M. M.
Campbell, W. M.
Carroll, F. E.
Cartee, W. R.
Casper, H.
Cobb, P. W.
Coleman, J. C.
Converce, W. A.
Conner, E. C.
Cornelius, R. D.
Crittenden, P. L.
Dalzell, J. T.
Denges, P. G.
Dear, R. C.
Decrow, V. R.
Deer, W. H.
Dyson, R. F.
Eakin, Dr.
Early, G. G.
Early, J. N.
Eaton, A. L. G.
Edmonds, J. F.
Edwards, A. D.
Elder, T. W. Jr.
Evans, E.
Evans, T. J.
Farquhar, L. C.
Fennerty, W. J.
Finlayson, Wm.
Floyd, W. F.
Folds, G. R.
Floersheim, B.
Gardner, R. C.
Garrett, C. W.
Garwood, A. L.
Gibson, R. A.
Gifford, H. N.
Glasgow, W. C.
Gorham, A. E.
Graff, E. D.
Gray, E.
Haggerty, J. F.
Hahn, N. R.
Hahn, H. A.
Hahessey, Thos.
Haller, H. E.
Harsch, A. M.
Harris, J. L.
Harvey, W. B.
Hazen, J. C.
Hecker, G. C.
Hetzel, W. A.
Himmelright, R. J.
Hiles, E. K.
Hoffman, J. M.
Hogan, W. T.
Holtz, R. F.
Huchel, E. W.
Huchel, Wm. J.
Hufferd, J. F.
Hughes, W. H.
Hughes, Jos. T.
Hunter, J. S.
Irwin, E. P.
Irwin, Dr. J. K.
Jarrett, R. E.
Jones, J. G.
Kelley, W. H.
Kemp, D. M.
Kepperling, R.
Ketterer, F. P.
Knox, J. R.
Knight, E. H.
Kuhlman, H.
Kimberland, W. H.
Kummer, J.
Lewis, W. H.
Lewis, Wm. M.
Lewis, Jas. M.
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Lowther, Geo.
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Marshall, D. J.
Marshall, W. T.
Mason, R. L.
Miles, C. B.
Miller, C. W.
Morrison, W. H.
Morrison, W. F.
Morgan, D. G.

Morse, W. S.	Smith, F. C.
Murdoch, Wm.	Smith, Sion B.
Muse, S. E.	Sproot, N. H.
Mutener, J.	Stahley, H. O.
McBride, P. A.	Steel, L. C.
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McCollum, W. H.	Streib, G. A.
McGhee, W. S.	Streib, J. F.
McNulty, F. B.	Sturgeon, W. M.
Nagel, H. D.	Sugden, J. E. Jr.
Neilson, Wm.	Sullivan, A. W.
Niklaus, C. G.	Sullivan, J. L.
Noah, W. J.	Tarr, Geo. B.
Olivier, H. G.	Tarn, T. R.
Paschedag, C. C.	Thomson, J. E.
Peacock, W. W.	Thorne, C. E.
Pechstein, T. M.	Torey, G. F.
Penn, C. D.	Vahring, Mr.
Phillips, W. H.	Vaughn, C.
Prentice, L. V.	Vernon, L. B.
Pyle, Jas. R.	Viehman, R. G.
Ray, W. H.	Viehman, C. E.
Rebstock, J. B.	Wachter, H. R.
Rese, Chas. H.	Wagstaff, Geo.
Reymer, R. E.	Wahlert, H. A.
Reynolds, D. E.	Walter, C. P.
Robertson, C.	Walton, H. R.
Rogers, J. L.	Wessell, W. F.
Rose, J. J.	Weller, L.
Rosser, W. L.	Williams, J. B.
Rubert, J.	Wibner, A. J.
Saul, J. A.	Wilson, W. W.
Sihlihr, G. C.	Wood, E. T.
Scheck, H. A.	Wood, H. L.
Shallenberger, F. E.	Wyrough, F. A.
Smith, Chas. P.	Yungman, E.

Zimmerman, O. J.

The call of the roll was dispensed with, the attendance being secured by the registration cards.

The reading of the minutes was dispensed with, they being in the hands of the printer and about ready for mailing.

The following applications for membership were read by the Secretary:

Anderson, A. E. President and Counsel, Pittsburgh District R. R. Co., 420 Bessemer Building, Pittsburgh, Pa. Recommended by D. C. Courtney.

Bair, A. H. Boiler Inspector, Union R. R., 300 Grant Street, Turtle Creek, Pa. Recommended by J. W. Wyke.

Barr, John D. Foreman Paint Shop, Pittsburgh Railways Co., 611 Center Street, Avalon, Pa. Recommended by Harry Howe.

Barry, J. I. Sales Engineer, Ferro Machine & Foundry Co., 4525 Plummer Street, Pittsburgh, Pa. Recommended by T. J. Riley.

Batty, John Boiler Inspector, Fidelity & Casualty Co., 11 Buffalo Street, Oakland, Pittsburgh, Pa. Recommended by F. M. McNulty.

Bowden, J. F. Division Supt. Motive Power, B. & O. R. R., Wheeling, W. Va. Recommended by J. H. Cooper.

Carroll, F. E. Assistant Foreman, Westinghouse Air Brake Co., 5 Penn Avenue, Irwin, Pa. Recommended by J. Battenhouse.

Cartee, W. R. Buyer, Westinghouse Electric & Manufacturing Co., 468 Swissvale Avenue, Wilkinsburg, Pa. Recommended by Harry Howe.

Cartwright, Wm. E. Salesman, Damascus Bronze Co., 928 South Avenue, North Side, Pittsburgh, Pa. Recommended by F. M. McNulty.

Collins, Wm. Car Foreman, Monon. Conn. R. R., 4166 Second Avenue, Pittsburgh, Pa. Recommended by A. E. Herrold.

Cornelius, R. D. Foreman, Pressed Steel Car Co., Green's Hotel, McKees Rocks, Pa. Recommended by Harry Howe.

Dean, A. W. Foreman, B. & O. R. R., 5119 Lodonia Street, Hazelwood, Pittsburgh, Pa. Recommended by Gus. Sigafoos.

Deems, N. A. Master Mechanic, B. & O. R. R., 218 Winston Street, Hazelwood, Pittsburgh, Pa. Recommended by Gus. Sigafoos.

Dobson, E. H. Assistant Division Engineer, B. & O. R. R., B. & O. R. R., Passenger Station, Pittsburgh, Pa. Recommended by J. W. Spielmann.

Evans, Evan Locomotive Engineer, Union R. R., 111 Camp Avenue, Braddock, Pa. Recommended by J. W. Wyke.

Evans, T. J. Electrician, Pressed Steel Car Co., 42 Highland Avenue, McKees Rocks, Pa. Recommended by E. L. Antes.

Fox, H. K. Motive Power Inspector, W. M. R. R., Hagerstown, Md. Recommended by S. W. Caton.

Francis, W. S. Salesman, Martell Packing Co., 5827 Alder St., Pittsburgh, Pa. Recommended by F. M. McNulty.

Grantier, L. V. Motive Power Inspector, B. & O. R. R., 1008 House Building, Pittsburgh, Pa. Recommended by J. H. Cooper.

Gray, Elijah Per Diem Clerk, Monon. Conn. R. R., 69 Freeland Street, Pittsburgh, Pa. Recommended by A. E. Herrold.

Haggerty, John F. Roundhouse Foreman, B. & O. R. R., 204 Renova Street, Glenwood, Pittsburgh, Pa. Recommended by Gus. Sigafoos.

Hogan, W. T. Sales Agent, Wolf Brush Co., 111 Maple Avenue, Edgewood, Pa. Recommended by D. M. Howe.

Huchel, E. W. Clerk, Inspection Department, Carnegie Steel Co., 668 Frick Building Annex, Pittsburgh, Pa. Recommended by H. G. Huchel.

Hufford, J. F. Md. Pennsylvania R. R., Elrama, Pa. Recommended by W. P. Conner.

Hughes, Joseph T. Assistant Manager, H. M. Myers Shovel Co., Beaver Falls, Pa. Recommended by D. H. Amsbary.

Irwin, E. P. Chief Clerk, M. C. B., Monon. Conn. R. R., 336 Atwood Street, Pittsburgh, Pa. Recommended by A. E. Herrold.

Jones, N. P. Storekeeper, Monon. Conn. R. R., 4166 Second Avenue, Pittsburgh, Pa. Recommended by A. E. Herrold.

Knight, E. H. Assistant Chief Engineer, Montour R. R., 1711 State Avenue, Coraopolis, Pa. Recommended by F. H. Stark.

Langfitt, J. W. Chief Clerk, B. & O. R. R., 4810 Monongahela Street, Hazelwood, Pa. Recommended by Gus. Sigafoos.

Malon, I. F. Car Accountant, Montour R. R., 8 Market Street, Pittsburgh, Pa. Recommended by F. H. Stark.

Marsh, H. B. Superintendent Liability Department, General Accounting Corp. Ltd, Farmers Bank Building, Pittsburgh, Pa. Recommended by Harry Howe.

Marshall, W. T. Chief Clerk to Auditor, Montour R. R., 8 Market Street, Pittsburgh, Pa. Recommended by F. H. Stark.

Masterson, Thos. Yard Master, B. & O. R. R., 3706 Charlotte Street, Pittsburgh, Pa. Recommended by Gus. Sigafoos.

Mason, R. L. R. R. Sales Manager, Hubbard & Co., Pittsburgh, Pa. Recommended by D. H. Amsbary.

Mertz, G. H. Car Service Clerk, Monon. Conn. R. R., 5034 Lytle Street, Pittsburgh, Pa. Recommended by A. E. Herrold.

Nones, Herbert R. Lieutenant of Police, Pressed Steel Car Co., 604 Chartiers Avenue, McKees Rocks, Pa. Recommended by Harry Howe.

Pastre, H. A. Special Representative Liberty-Elliott Co., 6905 Susquehanna Street, Pittsburgh, Pa. Recommended by D. H. Amsbary.

Provost, J. P. Vice President and Secretary Union Electric Co., 31 Terminal Way, Pittsburgh, Pa. Recommended by D. H. Amsbary.

Ridley, R. C. Locomotive Engineer, Union R. R., 1915 Monroe Street, Swissvale, Pa. Recommended by J. W. Wyke.

Rowand, T. A. Auditor, Montour R. R., 8 Market Street, Pittsburgh, Pa. Recommended by F. H. Stark.

Schaff, A. J. Chief Engineer Marine Department Monon. River Con. Coal & Coke Co., Pittsburgh, Pa. Recommended by F. H. Stark.

Scott, W. W. Jr. Engineer, Carnegie Steel Co., 427 Carnegie Building, Pittsburgh, Pa. Recommended by Chas. Orchard.

Shaw, H. D. Car Inspector, Monon. Conn. R. R., 219 Winston Street, Hazelwood, Pa. Recommended by A. E. Herrold.

Smith, Chas. P. Captain of Police, Pressed Steel Car Co., 113 Woodlawn Avenue, Bellevue. Recommended by Harry Howe.

Sullivan, A. W. Sales Agent, Railway Steel Spring Co., Pittsburgh, Pa. Recommended by H. V. Porter.

Wessell, W. F. Roundhouse Foreman, Monon. Conn. R. R., 3933 Hoosac Street, Pittsburgh, Pa. Recommended by Wm. Penn.

Wood, H. L. Representative Rail Joint Co., 2245 Oliver Building, Pittsburgh, Pa. Recommended by E. A. Conduit, Jr.

Wahlert, H. A. Engineer, Westinghouse Air Brake Co., Wilmerding, Pa. Recommended by J. H. Cooper.

Yungman, Edgar Division Passenger Agent, Pennsylvania Lines, Oliver Building, Pittsburgh, Pa. Recommended by D. H. Amsbary.

Zimmerman, O. J. Superintendent Montour R. R., 1711 State Avenue, Coraopolis, Pa. Recommended by F. H. Stark.

PRESIDENT MITCHELL: As soon as these names have been favorably acted on by the Executive Committee the gentlemen will become members.

SECRETARY: At the last meeting the following amendment to the Constitution was submitted, which under the rules had to lie over until this meeting for action and being a proposal to amend the Constitution, it will require a two thirds vote of the membership present to adopt.

"In keeping with the increase in membership of the Club it is thought desirable that the Executive Committee should consist of three or more members, instead of only three members, therefore we the undersigned members of the Club offer the following amendment to the Constitution:

Article IV, Officers, that the words "three elective Executive members" be changed to read "an elective Executive Committee of three or more members."

Article VI, Election of Officers, Sec. 2 and 3—Eliminate

the word "three" so that the different sentences will read "by elective members of the Executive Committee instead of by the three elective members of the Executive Committee."

(Signed by ten members of the Club)

ON MOTION and resolution was adopted by the unanimous vote of the members present.

PRESIDENT MITCHELL: Next will be the annual report of the Secretary.

To the Officers and Members of
The Railway Club of Pittsburgh,

Gentlemen:

I beg to submit a statement of the events closing the thirteenth year of the Club.

During the year death has removed from our midst the following members: Joseph A. Shremp, J. McAndrews, J. McC. Barwis and Tom R. Davis.

The advertisers in our Official Proceedings have given us unusually good support this year considering the depression in business, the number being increased ten with a loss of only two.

The papers presented at the meetings were no doubt of interest because of the large attendance of the members who brought out valuable discussion on each subject. The total attendance of members and visitors during the year was 1867 an average of 207 per meeting.

The following is a summary of the membership, financial conditions, etc., for the year up to and including this meeting:

MEMBERSHIP.

Reported last year	1052	
Received into membership during the year	196	
Reinstated	6	
		1254
Suspended for non-payment of dues	114	
Resigned	49	
Loss of address	17	
Removed by death	4	
		184
Present membership		1070

FINANCIAL.

Receipts.

In hands of Treasurer last year	$2,607.53	
From dues	2,379.00	
From advertising	2,052.20	
From sale of Official Proceedings and other sources	283.00	
Interest on Savings Account	41.60	
Interest on check account	22.74	
Total		$7,386.57

Disbursements.

Printing Proceedings, advance sheets, notices and postage	$2,378.45	
Hall rent, lunch and cigars for Club meetings	697.63	
Premium on bonds, Secretary and Treasurer.	17.50	
Secretary's expenses M. C. B. Convention	50.00	
Stereopticon light for illustrating papers	40.00	
Office stationery and supplies	144.78	
Entertainment of members and guests	352.17	
Reporting proceedings of meetings	120.00	
Secretary's salary 1913-1914 and expense of advertising	805.22	
Auditing accounts of Secretary and Treasurer	25.00	
Contribution to University of Pittsburgh fund	100.00	
Messenger service	16.00	$4,746.75
Balance in hands of Treasurer		$2,639.82

Respectfully submitted,

J. B. ANDERSON,
Secretary.

Approved:

L. H. TURNER,
D. J. REDDING,
F. R. MCFEATTERS,
Executive Committee.

PRESIDENT MITCHELL: We will now hear the annual report of the Treasurer.

To the Officers and Members of
The Railway Club of Pittsburgh,
Gentlemen:

I beg to submit the following report for the year ending October 23rd, 1914:

Receipts.

Balance on hand from last year	$2,607.53	
Received from the Secretary during the year	4,714.70	
Interest on Savings account ($1,000.00)	41.60	
Interest on Checking account	22.74	
Total		$7,386.57

Disbursements.

Paid out on Secretary vouchers	$4,746.75	$4,746.75
Balance on hand		$2,639.82

Respectfully submitted,

F. H STARK,
Treasurer.

Approved:
L. H. TURNER,
D. J. REDDING,
F. R. MCFEATTERS,
Executive Committee.

PRESIDENT MITCHELL: The reports of the Secretary and Treasurer will be referred to the Executive Commitee for approval.

Next in order is the report of the election of officers.

MR. D. J. REDDING: Mr. President and Gentlemen:—On behalf of the Executive Committee I have the pleasure of announcing the result of the election to be as follows:

President—F. M. McNulty, Superintendent M. P. & R. S., Monongahela Connecting R. R.

First Vice-President—J. G. Code, General Manager, Wabash-Pittsburgh Ter. R. R.

Second Vice-President—H. H. Maxfield, Master Mechanic, Pennsylvania R. R.

Secretary—J. B. Anderson, Chief Clerk to Supt. Motive Power, Pennsylvania R. R.

Treasurer—F. H. Stark, General Superintendent, Montour R. R.

Executive Committee—L. H. Turner, Superintendent Motive Power, P. & L. E. R. R.; D. J. Redding, Assistant Superintendent Motive Power, P. & L. E. R. R.; F. R. McFeatters, Superintendent Union R. R.; A. G. Mitchell, Superintendent Monongahela Division, Pennsylvania R. R.

Finance Committee—D. C. Noble, President, Pittsburgh Spring & Steel Co.; E. K. Conneely, Purchasing Agent, P. & L. E. R. R.; C. E. Postlethwaite, Manager Sales, Pressed Steel Car Co.; A. L. Humphrey, Vice-President and General Manager, W. A. B. Co.; L. C. Bihler, Traffic Manager, Carnegie Steel Co.

Membership Committee—D. M. Howe, Manager, Jos. Dixon Crucible Co.; Chas. A. Lindstrom, Assistant to President, Pressed Steel Car Co.; A. Stucki, Engineer; C. O. Dambach, Superintendent Wabash-Pittsburgh Ter. R. R.; O. S. Pulliam, Secretary, Pittsburgh Steel Foundry Co.; Frank J. Lanahan, President, Fort Pitt Malleable Iron Co.; Harry Howe, Inspector of Castings, Pressed Steel Car Co.

Entertainment Committee—Stephen C. Mason, Secretary, The McConway & Torley Co.; R. H. Blackall, Railway Supplies; D. H. Amsbary, District Manager, Dearborn Chemical Co.

A noticeable thing about these returns is that while most of the candidates received from 270 to 273 votes, the retiring President, Mr. Mitchell, received 275 votes for member of the Executive Committee, showing the anxiety of the membership to retire him to the Executive Committee!

PRESIDENT MITCHELL: I think you will be interested in hearing from these gentlemen whom you have elected to the several offices in the Club. I will, therefore, call upon

Mr. McNulty, who has been elected President for the ensuing year.

MR. F. M. McNULTY: Mr. President, officers and members of the Railway Club, I thank you most heartily for the honor conferred in electing me President of this Club. In accepting this office, however, I feel a sense of great responsibility, and if it were not for the strong Executive Committee and the warm sympathy of the members, I would not feel capable of assuming these duties.

Being a charter member of the Club, I have always been interested in its growth and development, and I assure you that I will continue to work for its best interest. I trust this will be a year of profit as well as pleasure to you all. Again I thank you.

PRESIDENT MITCHELL: Mr. Code, who has been elected first vice-president.

MR. J. G. CODE: Mr. President and gentlemen:—I sat up nights for about a week preparing an address to be delivered on this momentous occasion. But coming out here my friend Howe said if I was going to make a speech he would not get a chance to say anything. Dave Redding talked the same way. Professor Endsley thought he ought to have a show and Mr. Bihler would rather sing a song than hear me talk. They turned me over to the Entertainment Committee who sat right down on me, said they were running this show and I would have to cut it out. So that all I can do is to thank you gentlemen for the honor you have conferred on me and to assure you of my interest in the welfare of the Club and my earnest purpose to promote it by every means to me possible. Again I thank you.

PRESIDENT MITCHELL: Mr. Maxfield, who has been elected to the office of second vice-president.

MR. H. H. MAXFIELD: Mr. President and gentlemen:—I escaped Mr. Code's predicament because I talked to some of my friends before trying to write a speech. I know you do not want to hear much tonight because for one reason, I can not speak fluently and secondly, you have too much going on after this. I am certainly very much gratified to be elected an officer of this Club and I shall do all I can to promote its progress and to keep the wheels moving, especially as Mr.

Turner has promised that we shall not be troubled with stuck brakes.

PRESIDENT MITCHELL: Mr. Anderson, who has been re-elected Secretary.

MR. J. B. ANDERSON: Mr. President and fellow-members of the Club:—I wish to thank you for re-electing me to the office of Secretary. During the past three years I have tried to bring The Railway Club of Pittsburgh to the front as much as possible, which of course I will leave to your judgment. Without any braggadocia on my part I want to relate a little something that possibly all of you do not know, with reference to the prominence our Club has achieved. At the present time your Secretary is Chairman of the Society of Railway Club Secretaries of the United States. He is also one of the advisory committee of the Society of Technical Association Secretaries of North America, which is going to convene in New York City on October 31st, and while serving in these capacaties, I assure you that every effort on my part will be toward pushing The Railway Club of Pittsburgh up to the top.

PRESIDENT MITCHELL: Mr. Stark, who has been re-elected Treasurer.

MR. F. H. STARK: Mr. President and gentlemen:—I thank you for the trust you have confided in me by again risking your money in my possession. I want to assure you that through the efforts of your Secretary, we shall be able to make a financial report that will be a credit to the Club. We must give credit to our retiring President and to our Secretary for the rapid growth during the past two years.

I was asked to say just a few words regarding the past and I trust you will bear with me for just a few minutes. One of the Officials of the Club was delegated to do this, but he modestly declined a few moments ago, consequently I am not prepared to make any remarks that will do justice to the subject.

This Club has acquired an enviable record. It is perhaps second or third numerically, but first in point of usefulness and fraternally. In this Pittsburgh district we have a wonderful field of opportunity, encouraging us to continued effort.

I desire to refer to some of the men of prominence who

have delivered addresses before this Club, which is a credit to any organization. Many of them I am not able to call to my mind at the present time, but as I have been sitting here thinking over the names, I recall Colonel Schoonmaker of the Little Giant; Mr. Schoyer of the Pennsylvania Lines; Mr. B. A. Worthington, at one time with the Wabash-Pittsburgh Terminal; Dr. Hammerschlag, of the Carnegie Technical Schools; Mr. L. H. Turner, practically the father of this organization; Mr. D. F. Crawford, a prominent motive power man. Dr. J. Leonard Levy, of Pittsburgh, whom you all know; Dr. Cotton, who occupied a chair in Princeton University; Mr. J. M. Myer, Director of Physical Research of the Carnegie Steel Company; Mr. A. H. Rudd, Chief Signal Engineer of the Pennsylvania; Mr. Julian Kennedy, a noted consulting Engineer; Mr. Samuel O. Dunn, Editor of the Railway Age Gazette; also others that I fail to recall and last but not least, our beloved Dr. Brashear, who I hope will be given an opportunity to speak to us before the close of the evening. Gentlemen, we have been eminently fortunate in obtaining such men of affairs to co-operate with us; then, too, our membership in general have taken their place and part, by attendance, free discussion of subjects; also cultivating a fraternal spirit, all contributing to the success of our organization.

We have further occasion to express our appreciation:—You are all aware that our retiring President has given his time, effort and influence for the benefit of this Club during the last two years. We are honored to have a man of his position and character to preside over our Club, consisting of all branches of railroading, manufacturing and shipping interests. Our President has presided in an especially able, urbane and impartial manner. I know that this Club will ever remember Mr. Mitchell for his successful administration. His whole life is full of grace and harmony. There is nothing more appropriate to associate our retiring President with, than the concord of sweet music. Knowing that his home ties are so dear to him, that he and his family love music, the Club has thought it very fitting that a small token of our esteem should be presented to Mr. Mitchell, in the form of a Victrola with a fine selection of records. We trust that he will accept from the Club this token of our esteem, and may it add in a measure to his happy domestic and social life.

MR. A. G. MITCHELL: Gentlemen and friends, it is impossible for me to express to you my feelings at this time. There is nothing so dear to a person as friendship. While it has been a pleasure to me to serve this Club in the capacity I have and especially pleasant to hear your words of commendation when I am about to retire from that position, yet we all know that words and phrases are shallow when compared with true friendship. In accepting this present I receive it as a token of the esteem of the members of the Club, and on behalf of myself and my family, who will also greatly enjoy it, I thank you. I hope that you will all remember where I live, and that you will come and see me and let me entertain you with beautiful music which is so pleasant to us all. It will double the pleasure to share it.

Several very fine selections were played upon the Victrola adding greatly to the pleasure of the occasion.

PRESIDENT MITCHELL: We have but one honorary member with us tonight, and that is Uncle John Brashear. We will be glad to hear from our honored Member.

DR. JOHN A. BRASHEAR: Mr. President, I know and everybody else here knows that it would be criminal for me to talk more than three minutes, and I would not talk at all if this good fellow here—and he is a good fellow and you all know it—had not insisted that I say a few words.

I have been wondering what I could say that would be of interest, and it occurred to me to say to you that what we in Pittsburgh possess in the way of scientific knowledge and attainments is due in very large measure to a magnificent railroad man who has gone over to the other side; I refer to William Thaw. We all ought to hold that man in dearest memory. When I was a mechanic in the rolling mill, he came after me. I did not know his wonderful work for and interest in the Allegheny Observatory at that time, but meeting him then on one occasion, he asked me to come and see him. I remember he told me he had been reading about the new comet I had written an article about in the Chronicle. He said "sit down, I want to talk with you" and, lying on the lounge in the old Fifth avenue home, inside of a half hour I believe that man knew my life from the time I was born until the time he met me. It was he who fostered Professor Langley in all his wonderful work and gave

to the Allegheny Observatory a sum that would today be considered a fortune. He gave Langley not less than $75,000 for his wonderful researches in astronomy and to him—you may not know it, to Mr. Thaw is due in a large measure the success of Langley's work in the study of aviation and aerodynamics and the heavier-than-air flying machine. When everybody else was crying "Darius Green" to Langley, Mr. Thaw took it up, and his project furnished the money that made Langley's studies a wonderful success. Gentlemen, when I was up in a flying machine, twenty-two hundred feet above the level of the plain, my only wish was to have Langley by my side. And I think I would like to have had my good friend, William Thaw with me also.

These memories of your railway vice-president are very sweet to me. That man stood by me to the very end of his life. He used to often say to me, "Why don't you come to me when you need advice or funds?" He knew there was no money in scientific work, if it was truly scientific. He was a man among men, and none of you know or ever will know all the good which that grand men did during his lifetime.

He used to take me occasionally to see William McCullough, and some of the boys told me a story about this other vice-president that you railroad men may perhaps enjoy. Mr. McCullough went to Cincinnati to do something in connection with the railroad business, and starting homeward, he had to go to a meeting in Philadelphia and said to the engineer—the officials then knew every engineer by name—"Jim, I want to get to Pittsburgh in time to take the train for Philadelphia. We are going to have a trustee meeting and I have to be there." Jim said, "All right," but he went rather too fast in part of his run for the old gentleman, and when they got to Columbus Mr. McCullough got out of his car, and going up to the engineer said, "Jim, I told you I wanted to go to Pittsburgh, not to hell."

I tell you I have found railroad men fine fellows. Our friend Smith, the stenographer, who is sitting here, will tell you that when his namesake, F. Hopkinson Smith, lectured before the Engineers Society at their banquet two years ago, he gave us a tirade against the poor railroad boys, commencing with the street car men, and then with the steam car men, and

all that sort of thing, and he scored them from beginning to end. I had a chance to get back at him when he told one of his stories about the hero of one of his novels who risked his life for others. I told him that right here in Pittsburgh we had two men, Bill Jones and Selwyn Taylor, who had sacrificed their own lives, trying to save the lives of their fellow-men. I tell you, there are lots of good men in this world and a lot of those good fellows are in this club and I am glad to be with them.

May I tell you that there is no man in this world that I think more of or have a higher opinion of than the locomotive engineer, and I never ride on a train that I do not watch my chance when I am going past him of looking up and saying, "Thank you for bringing us home safe." No one knows what a railroad engineer risks for our safety.

What Uncle John wishes for you is success in life, that you may go out from this meeting and make somebody else happy. It may be

> "Only a glad "Good morning"
> As you pass along the way;
> It will leave a ray of sunshine
> Over the livelong day."

It may be only three little good deeds that you did for the day, handing a boy two cents for a paper that is only one cent. Remember the boy who went to bed trying to think of three good things he had done during the day. He could think of but two, but hearing a racket on the floor he remembered that the mouse-trap had been set, so he got up and found the mouse caught in the trap. As it was not dead he took it out and gave it to the cat, so he went to sleep thinking of the three good things he did that day.

PRESIDENT MITCHELL: After the entertainment there will be lunch served in the Rathskeller, for which we hope all will stay. The remainder of the evening will now be in charge of the Entertainment Committee and if you are not pleased with the entertainment we hope you will be charitable, remembering that they are doing their best.

I will now turn the meeting over to Mr. D. H. Amsbary, who represents the Entertainment Committee.

MR. D. H. AMSBARY: Mr. President and gentlemen:—I wish to assure you that we are going to do our best and hope you will enjoy it.

The following programme was then carried out:

PROGRAM.

1. Moving picture .... (comic)
2. Song and Talk ....Fred. S. Hickey
   Representative Dearborn Chemical Company
3. Moving picture ....(Bock Beer Fiend)
4. Mystery....(none better) ....E. C. Adams
   Representative Anchor Packing Company
5. Moving picture ....(something real)
6. Doing not much of anything................Harry Barney
   Laughlin-Barney Machinery Co.
7. Moving picture ....(comic)
8. Italian sketch..................Harry Murdock and Pals
   H. Murdoch & Co.

Orchestra music—Julius Frey

Dutch lunch in the Rathskeller

The programme was especially interesting owing to the fact that a considerable portion of it was given by members of the Club who are more than usually expert in their various lines of entertainment.

MR. SION B. SMITH: I feel that some expression of the pleasure and appreciation of the audience is due to the Entertainment Committee and to our Secretary, who have collaborated in this most delightful evening's entertainment. Being in position to speak in a measure for both members and guests, I would like to move a rising vote of thanks to the members

of the Entertainment Committee and Secretary Anderson for their tireless efforts and their enviable success in providing for us this evening's programme.

The motion was seconded and carried by unanimous vote.

There being no further business,

ON MOTION, Adjourned.

NOTE: This meeting was the largest ever held in the history of the Club and was enjoyed by all present. Each one on entering the Auditorium was presented with a "Smokers" package containing a Calabash pipe, tobacco, cigars and matches.

The lunch in the Rathskeller was of the German style and appealed to those who partook of the same.

J. B. Anderson
Secretary.

The Railway Club of Pittsburgh

CONSTITUTION

Article I.

The name of this organization shall be "The Railway Club of Pittsburgh."

Article II.

OBJECTS.

The objects of this Club shall be mutual intercourse for the acquirement of knowledge, by reports and discussion, for the improvement of railway operation, construction, maintenance and equipment, and to bring into closer relationship men employed in railway work and kindred interests.

Article III.

MEMBERSHIP.

Section 1. The membership of this Club shall consist of persons interested in any department of railway service or kindred interests, or persons recommended by the Executive Committee upon the payment of the annual dues for the current year.

Sec. 2. Persons may become honorary members of this Club by a unanimous vote of all members present at any of its regular meetings, and shall be entitled to all the privileges of membership and not be subject to the payment of dues or assessments.

Article IV.

OFFICERS.

The officers of this Club shall consist of a President, First Vice President, Second Vice President, Secretary, Treasurer, Finance Committee consisting of five members, Membership Committee consisting of seven members, Entertainment Committee consisting of three members, and an Elective Executive Committee of three or more members who shall serve a term of one year from the date of their election, unless a vacancy occurs, in which case a successor shall be elected to fill the unexpired term.

Article V.

DUTIES OF OFFICERS.

Section 1. The President shall preside at all regular or special meetings of the Club and perform all duties pertaining to a presiding officer; also serve as a member of the Executive Committee.

Sec. 2. The First Vice President, in the absence of the President, will perform all the duties of that officer; the Second Vice President, in the absence of the President and First Vice President, will perform the duties of the presiding officer. The First and Second Vice President shall also serve as members of the Executive Committee.

Sec. 3. The Secretary will attend all meetings of the Club or Executive Committee, keep full minutes of their proceedings, preserve the records and documents of the Club, accept and turn over all moneys received to the Treasurer at least once a month, draw cheques for all bills presented when approved by a majority of the Executive Committee present at any meetings of the Club, or Executive Committee meeting. He shall have charge of the publication of the Club Proceedings and perform other routine work pertaining to the business affairs of the Club under the direction of the Executive Committee.

Sec. 4. The Treasurer shall receipt for all moneys received from the Secretary, and deposit the same in the name of the Club within thirty days in a bank approved by the Executive Committee. All disbursements of the funds of the Club shall be by cheque signed by the Secretary and Treasurer.

Sec. 5. The Executive Committee will exercise a general supervision over the affairs of the Club and authorize all expenditures of its funds. The elective members of this Committee shall also perform the duties of an auditing committee to audit the accounts of the Club at the close of a term or at any time necessary to do so.

Sec. 6. The Finance Committee will have general supervision over the finances of the Club, and perform such duties as may be assigned them by the President or First and Second Vice Presidents.

Sec. 7. The Membership Committee will perform such duties as may be assigned them by the President or First and

Second Vice Presidents, and such other duties as may be proper for such a committee.

Sec. 8. The Entertainment Committee will perform such duties as may be assigned them by the President or First and Second Vice Presidents and such other duties as may be proper for such a committee.

Article VI.

ELECTION OF OFFICERS.

Section 1. The officers shall be elected at the regular annual meeting as follows, except as otherwise provided for:

Sec. 2. Written forms will be mailed to all the members of the Club, not less than twenty days previous to the annual meeting, by the elective members of the Executive Committee. These forms shall provide a method, so that each member may express his choice for the several offices to be filled.

Sec. 3. The elective members of the Executive Committee will present to the President the names of the members receiving the highest number of votes for each office, together with the number of votes received.

Sec. 4. The President will announce the result of the ballot and declare the election.

Sec. 5. Should two or more members receive the same number of votes, it shall be decided by a vote of the members present, by ballot.

Article VII.

AMENDENTS.

Amendments may be made to this Constitution by written request of ten members, presented at a regular meeting and decided by a two-thirds vote of the members present at the next regular meeting.

BY-LAWS

Article I.

MEETINGS.

Section 1. The regular meetings of the Club shall be held at Pittsburgh, Pa., on the fourth Friday of each month, except June, July and August, at 8:00 o'clock P. M.

Sec. 2. The annual meeting shall be held on the fourth Friday of October each year.

Sec. 3. The President may, at such times as he deems expedient, or upon request of a quorum, call special meetings.

Article II.

QUORUM.

At any regular or special meeting nine members shall constitute a quorum.

Article III.

DUES.

Section 1. The annual dues of members shall be Two dollars, One dollar of which to provide light refreshments for each meeting, payable in advance on or before the fourth Friday of September each year.

Sec. 2. The annual subscription to the printed proceedings of the Club shall be at the published price of One Dollar.

Sec. 3. At the annual meeting members whose dues are unpaid shall be dropped from the roll after due notice mailed them at least thirty days previous.

Sec. 4. Members suspended for non-payment of dues shall not be reinstated until all arrearages have been paid.

Article IV.

ORDER OF BUSINESS.

1—Roll call.

2—Reading of the minutes.

3—Announcements of new members.

4—Reports of Committees.

5—Communications, notices, etc.

6—Unfinished business.

7—New business.

8—Recess.

9—Discussion of subjects presented at previous meeting.

10—Appointment of committees.

11—Election of officers.

12—Announcements.

13—Financial reports or statements.

14—Adjournment.

Article V.

SUBJECTS—PUBLICATIONS.

Section 1. The Executive Committee will provide the papers or matter for discussion at each regular meeting.

Sec. 2. The proceedings or such portion as the Executive Committee may approve shall be published (standard size, 6x9 inches), and mailed to the members of the Club or other similar clubs with which exchange is made.

Article VI.

The stenographic report of the meetings will be confined to resolutions, motions and discussions of papers unless otherwise directed by the presiding officer.

Article VII.

AMENDMENTS.

These By-Laws may be amended by written request of ten members, presented at a regular meeting, and a two-thirds vote of the members present at the next meeting.

MEMBERS

Adams, Chas. F.,
Enginehouse Foreman,
P. R. R.,
79 No. First St.,
Duquesne, Pa.

Adams, Lewis,
Clerk, P. S. Car Co.,
4004 Northminister St.,
N. S., Pittsburgh, Pa.

Albert, Leon H.,
Traveling Fireman,
Penna. R. R.,
Elrama, Pa.

Albree, Chester B.,
President, Chester B. Albree
Iron Works Co.,
1201 Metropolitain St.,
N. S., Pittsburgh, Pa.

Alexander, J. R.,
Gen'l R. F. of E.,
Pennsylvania R. R. Co.,
Altoona, Pa.

Alleman, C. W.,
Sup'r. of Stores,
P. & L. E. R. R. Co.,
General Office,
Pittsburgh, Pa.

Allen, Harry L.,
Ass't. 4th Vice Pres't,
American Steel Foundries,
Alliance, Ohio.

Allen, Jas. P.,
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Union Steel Castings Co.,
61st and Butler Sts.,
Pittsburgh, Pa.

Allison, John,
Chief Engineer,
Pittsburgh Steel Fdy. Co.,
Glassport, Pa.

Altman, C. M.,
Asst. Foreman Car Insp.,
P. R. R. Co.,
R. F. D. No. 2,
Jeannette, Pa.

Amend, G. F.,
M. P. Insptor, P. R. R.,
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Amsbary, D. H.,
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632 N. Rebecca St.,
Stanton Heights,
Pittsburgh, Pa.

Andresen, A. M.,
Salesman, Chicago
Pneumatic Tool Co.,
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Pittsburgh, Pa.

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Pit Post Co.,
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McKees Rocks, Pa.

Anthony, J. T.,
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Anwyll, Arthur R.,
Estimator, Pressed Steel
Car Company,
Kenmore Apt.,
Avalon, Pa.

Arensberg, F. L.,
Asst. Mgr., McCullough-
Dalzell Crucible Co.,
36th St. and A. V. Ry.,
Pittsburgh, Pa.

Arnold, R. R.,
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Pennsylvania R. R. Co.,
Philadelphia, Pa.

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Davis-Bouronville Co.,
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49th St. and A. V. Ry.,
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Yard Master,
P. R. R. Monon. Div.,
Monongahela, Pa.

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56th St. Works,
The McConway & Torley
Co.,
Pittsburgh, Pa.

Bailey, R. E. L.,
Sec'y., American Spiral
Spring and Mfg. Co.,
56th St. and A. V. Ry.,
Pittsburgh, Pa.

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Gross St. and P. R. R.,
Pittsburgh, Pa.

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Galena Signal Oil Co.,
Whitehall Bldg.,
New York, N. Y.

Baker, Emmett C.,
Clerk, Union R. R.,
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Baker, J. H.,
Clerk, M. P. Dept.,
P. R. R. Co.,
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Assistant Superintendent,
Duquesne Steel Fdy. Co.,
Coraopolis, Pa.

Ball, Geo. L.,
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Barker, A. E.,
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Firth-Sterling Steel Co.,
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Barney, Harry,
Secretary and Treasurer,
Laughlin-Barney Machinery
Co.,
Union Bank Bldg.,
Pittsburgh, Pa.

Barr, John D.
Foreman, Paint Shop,
Pgh. Rys. Co.,
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Barron, Edward T.,
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Barry, J. I.,
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Machine and Foundry Co.,
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President, Bartley Automatic
Nut & Bolt Fastener Co.,
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Chief Engr. R. R. Dept.,
Joseph T. Ryerson & Son,
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Batchelar, E. C.,
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Merryweather Mach'y Co.,
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Vice Pres. and General Manager,
Althom Sand Co.,
421 Wood St.,
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Rep., Galena Signal Oil Co.,
Miller Park, Franklin, Pa.

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Land Title Bldg.,
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Bottomly, E. S.,
Chief Joint Inspector,
P. & R. and C. V. Rys.,
Martinsburg, W. Va.

Bowden, J. F.,
Div. Supt. M. P.,
B. & O. R. R.,
Wheeling, W. Va.

Bowden, T. C.,
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B. & L. E. R. R.,
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Train Master,
Montour R. R.,
Coraopolis, Pa.

Brandt, E. K.,
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Branson, Craig R.,
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Branthnger, J. H.,
Engineman, P. R. R.,
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Breese, E. W.,
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Brennan, E. J.,
Master Mechanic,
B. R. & P. Ry.,
DuBois, Pa.

Bretz, F. K.,
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town and Kingwood R. R.
Morgantown, W. Va.

Brewer, Wm. A.,
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Standard Ry. Equip. Co.,
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Briggs, Templeton,
Assistant Chief Inspector,
Carnegie Steel Co.,
Schoen Steel Works,
McKees Rocks, Pa.

Brower, R. M.,
Rep., American Brake Shoe
& Foundry Co.,
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Brown, A. D.,
C. C. to Genl. Manager,
P. & L. E. R. R. Co.,
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Pittsburgh, Pa.

Brown, Alexander M.,
General Manager,
Zug Iron & Steel Co.,
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Brown, D. S.,
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The Railway Equipment
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Brown, J. F.,
Fairbanks Co.,
29th and Liberty,
Pittsburgh, Pa.

Brown, John T., Jr.,
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Pittsburgh, Pa.

Brown, L. M.,
Salesman, McKenna Bros.,
107 Virginia Ave.,
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Pittsburgh, Pa.

Brownscombe, G. J.,
Clerk, Union R. R. Co.,
Port Perry, Pa.

Brunner, F. J.,
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Buckbee, W., A.
Slingerlands, N. Y.

Buckley, Wm.,
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Heat Insp'r., Penna. R. R.,
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Pittsburgh, Pa.

Camlin, A. D.,
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Carroll, J. T.,
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Power, B. & O. R. R.,
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Carroll, Frank E.,
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Carson, G. E.,
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N. Y. C. & H. R. R. R. Co.,
W. Albany, N. Y.

Cartee, W. R.,
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Cartwright, Wm. E.,
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Damascus Bronze Co.,
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Verona, Pa.

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Cato, J. R.,
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Forged Steel Wheel Co.,
Butler, Pa.

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Brewster, O.

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Cole, Joshua T.,
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Carr Foreman,
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Cresson, Pa.

Conneeley, E. K.,
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Conner, W. P.,
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Pittsburgh, Pa.

Warne, J. C.,
Supt., Penna.
Casting & Machine Co.,
505 Preble Ave.,
N. S., Pittsburgh, Pa.

Warner, E. O.,
The National Malleable Castings Co.,
1205 Franklin Bank Bldg.,
Philadelphia, Pa.

Warnock, Harry R.,
Sup't. M. P. W. M. Ry.,
Hagerstown, Md.

Watkins, G. E.,
Asst. Master Mechanic,
Penna. R. R.,
28th and Liberty St.,
Pittsburgh, Pa.

Watson, W. N.,
Gen'l. Foreman, Mach. Shop,
Pressed Steel Car Co.,
2700 California Ave.,
N. S., Pittsburgh, Pa.

Way, L. A.,
Supt., Duquesne Steel
Foundry Co.,
Coraopolis, Pa.

Waycott, Albert,
President.
Damascus Brake Beam Co.,
6906 Crosby Ave.,
Cleveland, O.

Weaver, F. R.,
Secretary and Treasurer,
Davis Brake Beam Co.,
Johnstown, Pa.

Weigel, Fred S.,
Asst. Train Master,
P. & L. E. R. R.,
1056 Dillon Ave.,
Coraopolis, Pa.

Weir, Robt. M.,
Supt., Yards,
Allegheny Steel Co.,
Brackenridge, Pa.

Weisbrod, J. F.,
Asst. to President.
National Car Wheel Co.,
Box 1230,
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Wendt, Edwin F.,
Member, Engr. Board,
Interstate Commerce Com.,
Washington, D. C.

Wenrich, M. L.,
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Penna. R. R. Co.,
2421 Beale Ave.,
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Wessell, W. F.,
Roundhouse Foreman,
Monon. Conn. R. R.,
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Wettach, Chas. D.,
Vice President, W. W.
Lawrence & Co., Inc.,
W. Carson St.,
Pittsburgh, Pa.

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Punxsutawney, Pa.

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Carnegie Steel Co.,
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Loco. Superheater Co.,
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Jones & Laughlin Steel Co.,
Fellsmere, Fla.

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Providence, R. I.

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P. & L. E. R. R. Co.,
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Maxwell & Moore,
1005 Park Bldg.,
Pittsburgh, Pa.

Williams, W. W.,
M. M., Crucible Steel Co.
of America,
30th and Smallman Sts.,
Pittsburgh, Pa.

Wills, J. F.,
Engineman, B. & O. R. R.,
Lytle St., Hazelwood Sta.,
Pittsburgh, Pa.

Wilson, J. T.,
President, American Balance
Valve Co.,
Jersey Shore, Pa.

Wilson, L. H., Jr.,
Transitman, B. & O. R. R.,
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Pittsburgh, Pa.

Wilson, R. F.,
Sup'r., P. R. R. Co.,
1716 Middle St.,
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Wilson, R. S.,
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Union R. R. Co.,
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P. R. R.,
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Buffalo Division,
Penna. R. R.,
Buffalo, N. Y.

Wittig, Wm.,
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Amer. Loco. Co.,
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W. A. B. Co.,
Wilmerding, Pa.

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Spring & Mfg. Co.,
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Clerk, P. R. R.,
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Verona Tool Works,
Verona, Pa.

Woods, Floyd F.,
Special Rep., Epping-
Carpenter Pump Co.,
1376 Montezuma St.,
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Woodside, S. P.,
General Freight Agent,
Wabash-Pittsburgh Ter. Ry.,
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Pittsburgh, Pa.

Wright, R. V.,
Managing Editor,
Railway Age Gazette,
Woolworth Bldg.,
New York, N. Y.

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Swissvale, Pa.

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Purchasing Dept.,
P. & L. E. R. R. Co.,
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Young, Wm. J.,
Draftsman, P. S. C. Co.,
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Pgh. Rys. Co.,
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Yungman, Edgar,
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Penna. R. R. Co.
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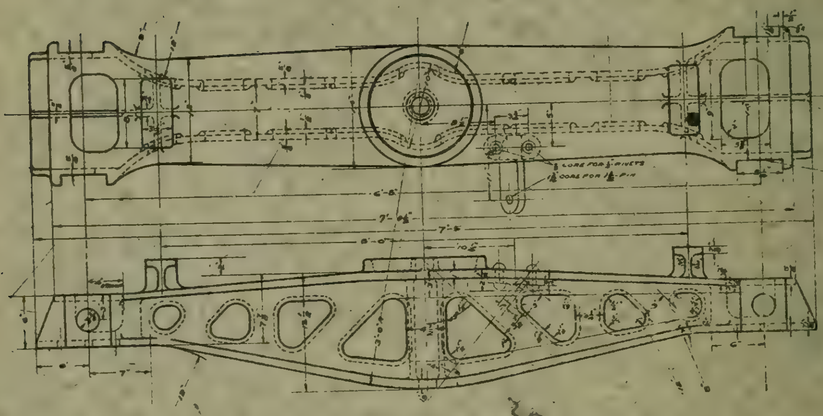
In Memoriam

TOM R. DAVIS

DIED

OCTOBER 13, 1914

PULLIAM II BEAM BOLSTER



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O. S. PULLIAM

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